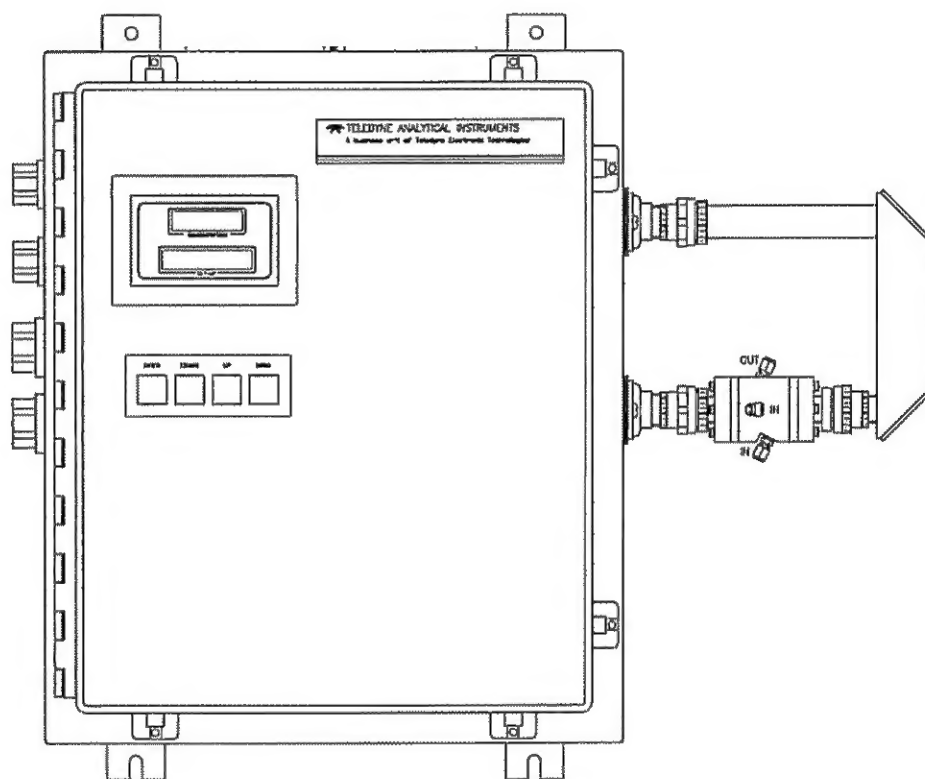




## OPERATING INSTRUCTIONS

# Model 5000BF

## Photometric Analyzer

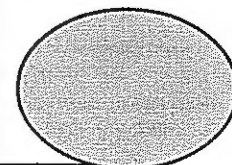


**DANGER**

HIGHLY TOXIC AND/OR FLAMMABLE LIQUIDS OR GASES MAY BE PRESENT IN THIS MONITORING SYSTEM.  
PERSONAL PROTECTIVE EQUIPMENT MAY BE REQUIRED WHEN SERVICING THIS SYSTEM

HAZARDOUS VOLTAGES EXIST ON CERTAIN COMPONENTS INTERNALLY WHICH MAY PERSIST FOR A TIME EVEN AFTER THE POWER IS TURNED OFF AND DISCONNECTED

ONLY AUTHORIZED PERSONNEL SHOULD CONDUCT MAINTENANCE AND/OR SERVICING. BEFORE CONDUCTING ANY MAINTENANCE OR SERVICING CONSULT WITH AUTHORIZED SUPERVISOR/MANAGER.



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**Warranty**

This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgements provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by Teledyne or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

**Important Notice**

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface, with the process being measured, be properly trained in the process itself, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of Teledyne at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

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## Model 5000BF



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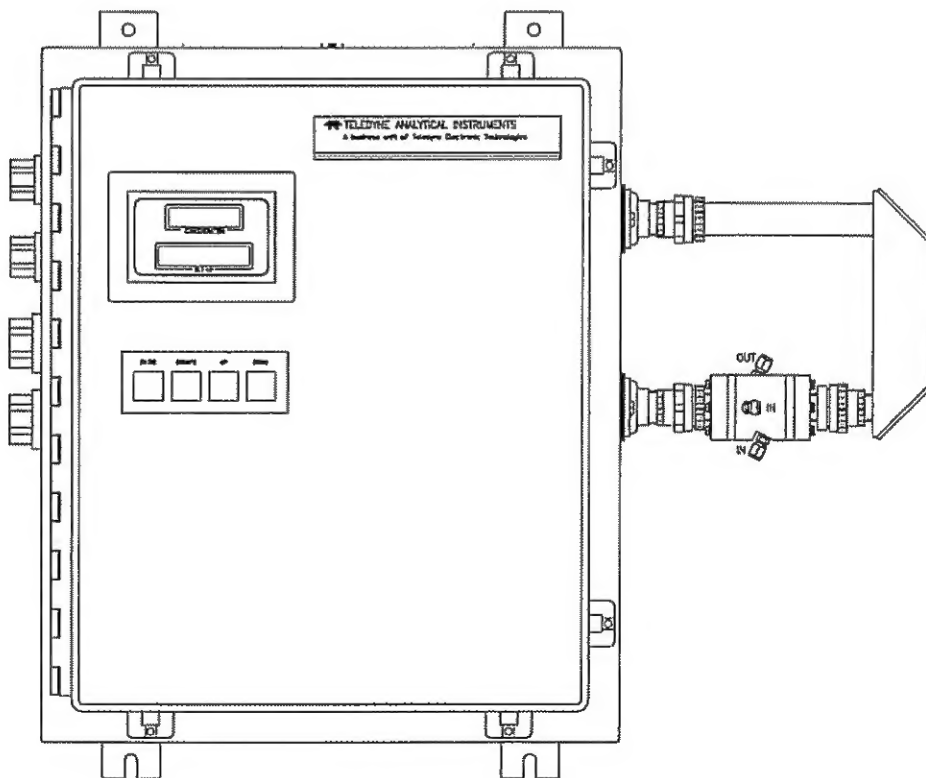
## OPERATING INSTRUCTIONS

# Model 5000BF

## *Photometric Analyzer*

### Part I: Control Unit

NEMA 4 Bulkhead Mount



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## Model 5000BF Photometric Analyzer

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## Introduction

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### 1.1 Overview

The Teledyne Analytical Instruments Model 5000BF Control Unit, together with a 5000BF Analysis Unit, is versatile microprocessor-based instrument.

Part I, of this manual covers the Model 5000BF General Purpose NEMA 4 Bulkhead Mount Control Unit. (The Analysis Unit is covered in Part II of this manual.) The Control Unit is for indoor/outdoor use in a nonhazardous environment only. The Control or Analysis Unit in the folded optics design can accommodate a variety of hazardous environments with either full explosion proof housings or Z, X, Y or Cenelec Purging functions.

### 1.2 Typical Applications

A few typical applications of the Model 5000BF are:

- 1.2 Typical Applications

#### *WATER MONITORING*

Background	Typical Range
Acids, including:	0–4000 PPM
Acetic	
Formic	
Sulfuric	
Acetaldehyde	0–1000 PPM
Air	0–2%
Alcohols, including:	0–400 ppm
Butanol	

---

Ethanol	
Isopropanol	
Methanol	
Alkanes, including:	0–500 ppm
Heptane	
Hexane	
Ammonia	0–1000 ppm and up
Aromatics, including:	0–500 ppm
Benzene	
Cumene	
Toluene	
Xylene	
Chlorinated Hydrocarbons including:	0–200 ppm
Carbon Tetrachloride	
Ethyl Chloride	
Ethylene Dichloride	
Methyl Chloride	
Perchloroethylene	
Propylene Dichloride	
Trichloroethylene	
Vinyl Chloride	
Chloroprene	0–200 ppm
Chloropicrin	0–200 ppm
Deuterium Oxide	0–200 ppm
Epichlorohydrin	0–2000 ppm
Ethylene Glycol	0–500 ppm
Freons	0–500 ppm
Gasoline	0–500 ppm

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Hydrogen Fluoride	0–10%
Hydroperoxides	0–5%
Kerosene	0–500 ppm
Ketones	0–1000 ppm
Methyl Acetate	0–1000 ppm
Methyl Methacrylate	0–1000 ppm
Oils	0–1%
Olefins	0–500 ppm
Pentane	0–300 ppm
$\alpha$ -Picolene	0–300 ppm
Phenol	0–1000 ppm
Polyols	0–500 ppm
Propylene Glycol	0–500 ppm
Propylene Oxide	0–200 ppm
Sulfinol	0–15%
Sulfur Dioxide	0–1000 ppm
Vinyl Acetate	0–2%

**NOTE:** Range may be higher or lower per application.

**OTHER NIR ABSORBERS (that can be measured)  
(consult factory)**

Acetic Acid

Alcohols

Amines

Aromatics

Butadiene

Carbonyls

Chloroprene

Esters

Hydroxyl Value

Hydrocarbons

Hydrogen Chloride

Hydrogen Fluoride

Hydroxyl Value

Ketones

Olefins

Oximes

Epoxides

Methylene

Ketones

### 1.3 Main Features of the Analyzer

The Model 5000BF Photometric Analyzer is sophisticated yet simple to use. The main features of the analyzer include:

- A 2-line alphanumeric display screen, driven by microprocessor electronics, that continuously prompts and informs the operator.
- High resolution, accurate readings of concentration from low ppm levels through to 100%. Large, bright, meter readout.
- Versatile analysis over a wide range of applications.
- Microprocessor based electronics: 8-bit CMOS microprocessor with 32 kB RAM and 128 kB ROM.
- Three user definable output ranges (from 0-1 ppm through 0-100 %) allow best match to users process and equipment.
- Calibration range for convenient zeroing or spanning.
- Auto Ranging allows analyzer to automatically select the proper preset range for a given measurement. Manual override allows the user to lock onto a specific range of interest.
- Two adjustable concentration alarms and a system failure alarm.
- Extensive self-diagnostic testing, at startup and on demand, with continuous power-supply monitoring.
- RS-232 serial digital port for use with a computer or other digital communication device.
- Analog outputs for concentration and range identification. (0-1 V dc standard, and isolated 4-20 mA dc)
- Superior accuracy.
- Internal calibration-Manual or Automatic (optional).

## 1.4 Operator Interface

All controls and displays on the standard 5000BF are accessible from outside the housing. The instrument has two simple operator controls. The operator has constant feedback from the instrument through an alphanumeric display, and a digital LED meter. The displays and controls are described briefly here and in greater detail in chapter 3. See Figure 1-1.

### 1.4.1 UP/DOWN Switch

The UP/DOWN switch is used to select between any subfunctions displayed on the VFD screen such as in the main menu, the system menu, the Alarm menu, etc. When modifiable values are displayed on the VFD, the UP/DOWN switch can be used to increment or decrement the values.

### 1.4.2 ESCAPE/ENTER Switch

The ESCAPE/ENTER switch is used to input the data, to enter a function, or to exit a function displayed in the alphanumeric display:

- **Escape** Moves VFD display back to the previous screen in a series. If none remains, returns to Analyze mode screen.
- **Enter** Within a menu: the function selected is entered moving on to the next screen in a series.

With Value selected: Enters the value into the analyzer as data. Advances cursor on VFD to the next operation.

In the Analyze mode: it calls the main menu.  
Functions called out by the main menu:

-System This function is a menu that calls a number of functions that regulate the analyzer operation.

-Span This function spans the instrument.

-Zero This function zeros the instrument.

-Alarms This functions sets the alarm preferences.

- Range This function selects whether analyzer is autoranging or locked on one range.
- Standby Places the analyzer in a sleep mode.

**WARNING:**

*The power cable must be disconnected to fully remove power from the instrument.*

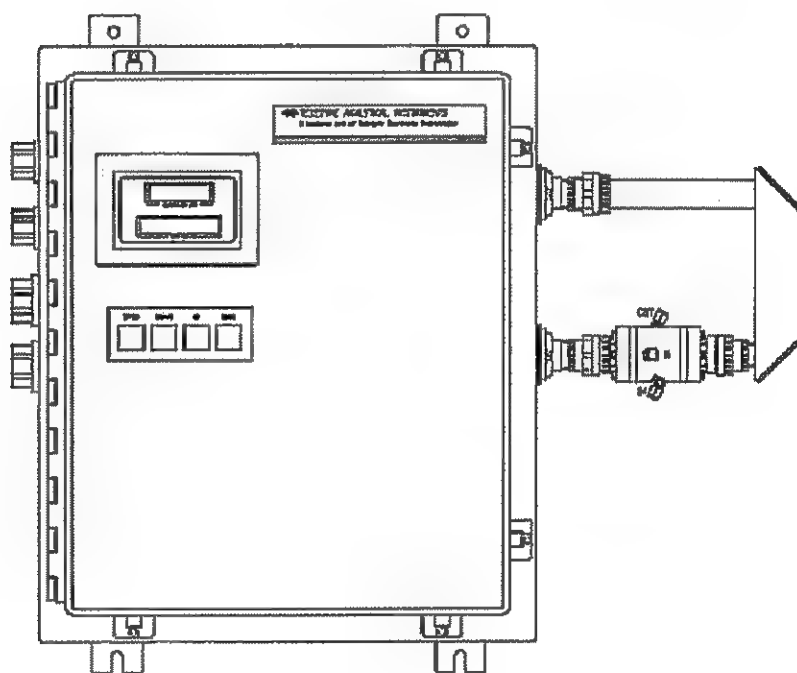


Figure 1-1: Model 5000BF Controls, Indicators, and Connectors

**Digital Meter Display:** The meter display is a Light Emitting Diode LED device that produces large, bright, 7-segment numbers that are legible in any lighting. It is accurate across all analysis ranges. The 5000BF models produce continuous readout from 0-10,000 ppm and then switch to continuous percent readout from 1-100 %.

**Alphanumeric Interface Screen:** The backlit VFD screen is an easy-to-use interface between operator and analyzer. It displays values, options, and messages for immediate feedback to the operator.

## 1.5 Control Section Interface Panel

The Control Section interface panel, shown in Figure 1-2, contains the electrical terminal blocks for external inputs and outputs. The input/output functions are described briefly here and in detail in the *Installation* chapter of this manual.

- |                       |   |
|-----------------------|---|
| • Power Connection    | AC power source, 115VAC, 50/60 Hz   |
| • Analog Outputs      | 0-1 V dc concentration and 0-1 V dc range ID. Isolated 4-20 mA dc and 4-20 mA dc range ID.                      |
| • Alarm Connections   | 2 concentration alarms and 1 system alarm.  |
| • RS-232 Port         | Serial digital concentration signal output and control input.   |
| • Remote Bench        | Provides all electrical interconnect to the Analysis Section.   |
| Remote Span/Zero      | Digital inputs allow external control of analyzer calibration.  |
| • Calibration Contact | To notify external equipment that instrument is being calibrated and readings are not monitoring sample.        |
| • Range ID Contacts   | Four separate, dedicated, range relay contacts.   |
| • Network I/O         | Serial digital communications for local network access. For future expansion. Not implemented at this printing. |

**Note:** If you require highly accurate Auto-Cal timing, use external Auto-Cal control where possible. The internal clock in the Model 5000BF is accurate to 2-3 %. Accordingly, internally scheduled calibrations can vary 2-3 % per day.







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## Installation

---

Installation of Model 5000BF Analyzers includes:

1. Unpacking, mounting, and interconnecting the Control/Analysis Section
2. Making gas connections to the system
3. Making electrical connections to the system
4. Testing the system.

This chapter covers installation of the Control Section. (Installation of the Analysis Section is covered in Part II of this manual.)

### 2.1 Unpacking the Control/Analysis Unit

The analyzer is shipped with all the materials you need to install and prepare the system for operation. Carefully unpack the Control/Analysis Unit and inspect it for damage. Immediately report any damage to the shipping agent. Figure 2-2: Required Front Door Clearance

Allow clearance for the door to open in a 90-degree arc of radius 15.5 inches. See Figure 2-2.

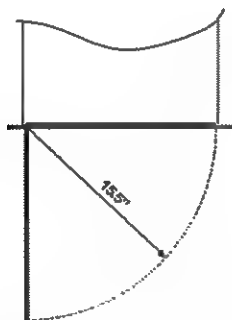


Figure 2-2: Required Front Door Clearance

### 2.2 Electrical Connections

Figure 2-3 shows the Control/Analysis Unit interface panel. Connections for power, communications, and both digital and analog signal outputs are described in the following paragraphs. Wire size and maximum length data appear in the Drawings at the back of this manual.

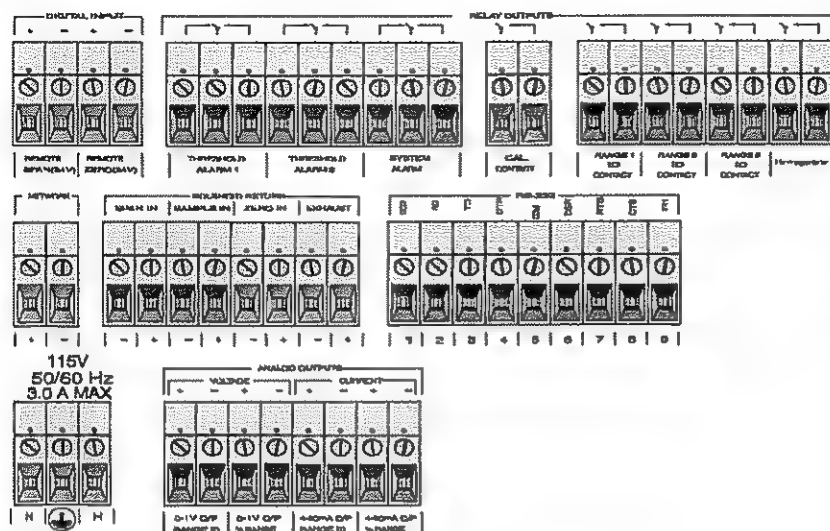


Figure 2-3: Interface Panel of the Model 6600 Control Section

For safe connections, ensure that no uninsulated wire extends outside of the terminal blocks. Stripped wire ends must insert completely into terminal blocks. No uninsulated wiring should come in contact with fingers, tools or clothing during normal operation.

**Primary Input Power:** The power supply in the Model 6600 will accept a 115 Vac, 50/60 Hz power source. See Figure 2-4 for detailed connections.

**DANGER:** Power is applied to the instrument's circuitry as long as the instrument is connected to the power source. The standby function switches power on or off to the displays and outputs only.

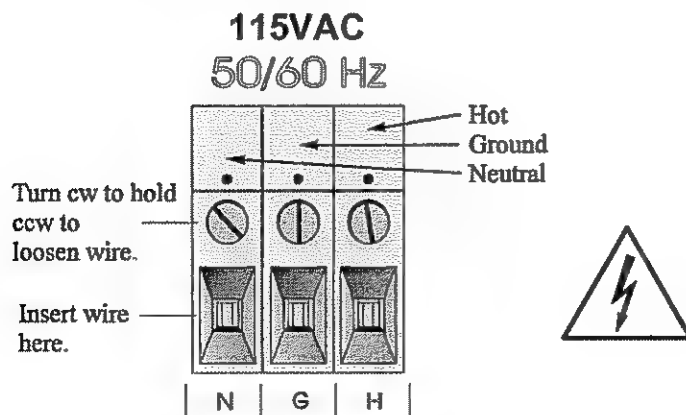


Figure 2-4: Primary Input Power Connections

**Fuse Installation:** The fuse holders accept 5 x 20 mm, 4.0 A, T type (slow blow) fuses. Fuses are not installed at the factory. Be sure to install the proper fuse as part of installation (See *Fuse Replacement* in chapter 4, *maintenance*.)

**Analog Outputs:** There are eight DC output signal connectors on the ANALOG OUTPUTS terminal block. There are two connectors per output with the polarity noted. See Figure 2-5.

The outputs are:

**0–1 V dc % of Range:** Voltage rises linearly with increasing sample concentration, from 0 V at 0% to 1 V at 100%. (Full scale = 100% programmed range.)

**0–1 V dc Range ID:** 0.25 V = Range 1, 0.5 V = Range 2, 0.75 V = Range 3.

**4–20 mA dc % Range:** Current increases linearly with increasing sample concentration, from 4 mA at 0% to 20 mA at full scale 100%. (Full scale = 100% of programmed range.)

**4–20 mA dc Range ID:** 8 mA = Range 1, 12 mA = Range 2, 16 mA = Range 3.

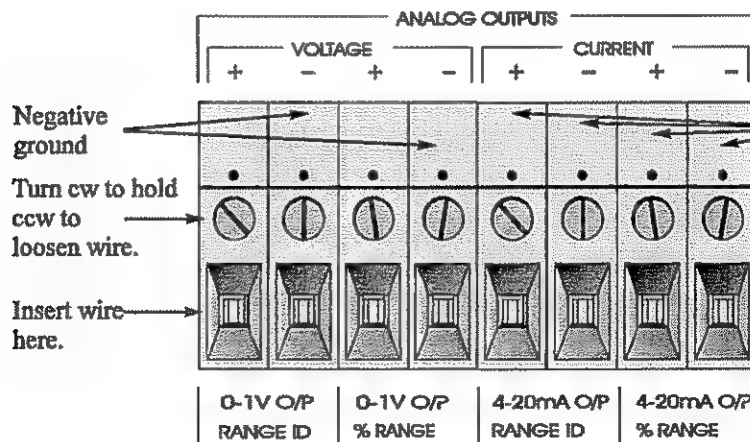


Figure 2-5: Analog Output Connections

Examples:

The analog output signal has a voltage which depends on the sample concentration AND the currently activated analysis range. To relate the signal output to the actual concentration, it is necessary to know what range the instrument is currently on, especially when the analyzer is in the autoranging mode.

The signal output for concentration is linear over currently selected analysis range. For example, if the analyzer is set on a range that was defined as 0-10 %, then the output would be as shown in Table 2-1.

**Table 2-1: Analog Concentration Output-Examples**

Concentration %	Voltage Signal Output (V dc)	Current Signal Output (mA dc)
0	0.0	4.0
1	0.1	5.6
2	0.2	7.2
3	0.3	8.8
4	0.4	10.4
5	0.5	12.0
6	0.6	13.6
7	0.7	15.2
8	0.8	16.8
9	0.9	18.4
10	1.0	20.0

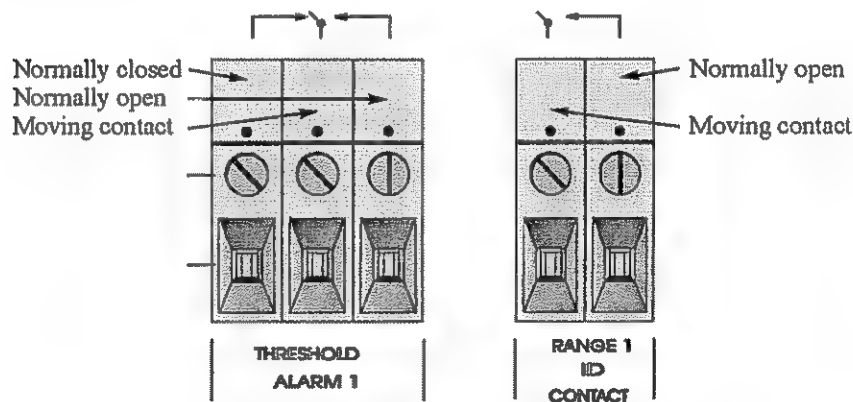
To provide an indication of the range, a second pair of analog output terminals are used. They generate a steady preset voltage (or current when using the current outputs) to represent a particular range. Table 2-2 gives the range ID output for each analysis range.

**Table 2-2: Analog Range ID Output - Example**

Range	Voltage (V)	Current (mA)
Range 1	0.25	8
Range 2	0.50	12
Range 3	0.75	16

**Alarm Relays:**

There are three alarm-circuit connectors on the alarm relays block (under RELAY OUTPUTS) for making connections to internal alarm relay contacts. Each provides a set of Form C contacts for each type of alarm. Each has both normally open and normally closed contact connections. The contact connections are indicated by diagrams on the rear panel. They are capable of switching up to 3 amperes at 250 V AC into a resistive load (Figure 2-6).

**Figure 2-6: Types of Relay Contacts**

*The connectors are:*

- Threshold Alarm 1:**
- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
  - Can be configured as fail-safe or non-fail-safe.
  - Can be configured as latching or nonlatching.
  - Can be configured out (defeated).

- Threshold Alarm 2:**
- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
  - Can be configured as fail-safe or non-fail-safe.
  - Can be configured as latching or nonlatching.
  - Can be configured out (defeated).
- System Alarm:** Actuates when DC power supplied to circuits is unacceptable in one or more parameters. Permanently configured as fail-safe and latching. Cannot be defeated. Actuates if self test fails.
- To reset a System Alarm during installation, disconnect power to the instrument and then reconnect it
- Further detail can be found in chapter 3, section 3-5.

### Digital Remote Cal Inputs

**Remote Zero and Span Inputs:** The REMOTE SPAN and REMOTE ZERO inputs are on the DIGITAL INPUT terminal block. They accept 0 V (OFF) or 24 V dc (ON) for remote control of calibration (See *Remote Calibration Protocol* below.)

- Zero:** Floating input. 5 to 24 V input across the + and – terminals puts the analyzer into the ZERO mode. Either side may be grounded at the source of the signal. 0 to 1 volt across the terminals allows ZERO mode to terminate when done. A synchronous signal must open and close the external zero valve appropriately. See *Remote Probe Connector* at end of section 3.3. (With the -C option, the internal valves automatically operate synchronously).
- Span:** Floating input. 5 to 24 V input across the + and – terminals puts the analyzer into the SPAN mode. Either side may be grounded at the source of the signal. 0 to 1 volt across the terminals allows SPAN mode to terminate when done. A synchronous signal must open and close the external span valve appropriately. See *Remote Probe Connector* at end of section 3.3. (With the -C option, the internal valves automatically operate synchronously.)

**Cal Contact:** This relay contact is closed while analyzer is spanning and/or zeroing. (See *Remote Calibration Protocol* below.)



**Remote Calibration Protocol:** To properly time the Digital Remote Cal Inputs to the Model 5000BF Analyzer, the customer's controller must monitor the Cal Relay Contact.

When the contact is OPEN, the analyzer is analyzing, the Remote Cal Inputs are being polled, and a zero or span command can be sent.

When the contact is CLOSED, the analyzer is already calibrating. It will ignore your request to calibrate, and it will not remember that request.

Once a zero or span command is sent, and acknowledged (contact closes), release it. If the command is continued until after the zero or span is complete, the calibration will repeat and the Cal Relay Contact (CRC) will close again.

For example:

- 1) Test the CRC. When the CRC is open, Send a zero command until the CRC closes (The CRC will quickly close.)
- 2) When the CRC closes, remove the zero command.
- 3) When CRC opens again, send a span command until the CRC closes. (The CRC will quickly close.)
- 4) When the CRC closes, remove the span command.

When CRC opens again, zero and span are done, and the sample is being analyzed.

**Note:** The Remote Bench terminal strip (section 3.6 Part III) provides signals to ensure that the zero and span gas valves will be controlled synchronously.

**Range ID Relays:** Four dedicated RANGE ID CONTACT relays . The first four ranges are assigned to relays in ascending order—Range 1 is assigned to RANGE 1 ID, Range 2 is assigned to RANGE 2 ID, Range 3 is assigned to RANGE 3 ID, and Range 4 is assigned to RANGE 4 ID.

**Network I/O:** A serial digital input/output for local network protocol. At this printing, this port is not yet functional. It is to be used in future versions of the instrument.

**RS-232 Port:** The digital signal output is a standard RS-232 serial communications port used to connect the analyzer to a computer, terminal, or other digital device. The pinouts are listed in Table 2-3.

**Table 2-3: RS-232 Signals**

RS-232 Sig	RS-232 Pin	Purpose
DCD	1	Data Carrier Detect

---

RD	2	Received Data
TD	3	Transmitted Data
DTR	4	Data Terminal Ready
COM	5	Common
DSR	6	Data Set Ready
RTS	7	Request to Send
CTS	8	Clear to Send
RI	9	Ring Indicator

The data sent is status information, in digital form, updated every two seconds. Status is reported in the following order:

- The concentration in percent
- The range is use (HI< MED< LO)
- The span of the range 0-100%, etc.
- Which alarm - if any - are disabled (AL-x DISABLED)
- Which alarms - if any - are tripped (AL-x ON)

Each status output is followed by a carriage return and line feed.

Three input functions using RS-232 have been implemented to date. They are described in Table 2-4.

**Table 2-4: Commands via RS-232 Input**

Command	Description
as<enter>	Immediately starts an autospan.
az<enter>	Immediately starts an autozero.
st<enter>	Toggling input. Stops/Starts any status message output from the RS-232, Until st<enter> is sent again.

The RS-232 protocol allows some flexibility in its implementation. Table 2-5 lists certain RS-232 values that are required by the 5000BF.

**Table 2-5: Required RS-232 Options**

Parameter	Setting
Baud	2400
Byte	8 bits
Parity	none
Stop Bits	1
Message Interval	2 seconds

**Remote Bench and Solenoid Valves:** The 5000BF is a single-chassis instrument. However, the REMOTE BENCH and SOLENOID RETURN connectors are provided on the interface PCB. The Remote Bench is wired at the factory as well as any optional solenoid valves included in the system.

## 2.3 Testing the System

After The Control/Analysis Unit is both installed and interconnected, and the system gas or liquid stream and electrical connections are complete, the system is ready to test. Before plugging the unit into its power sources:

- Check the integrity and accuracy of the fluid connections. Make sure there are no leaks.
- Check the integrity and accuracy of all electrical connections. Make sure there are no exposed conductors
- Check that sample pressure typically between 0 and 30 psig, according to the requirements of your process.

Power up the system, and test it by performing the following operation:

1. Repeat the Self-Diagnostic Test.
2. Zero the instrument.
3. Span the instrument.

Consult calibration recommendation in the addendum for your particular application whether liquid or gas phase monitoring.

For steps 2 and 3, refer to part II for calibration.



## Operation

---

### 3.1 Introduction

Although the Model 5000BF is usually programmed to your application at the factory, it can be further configured at the operator level, or even, **cautiously**, reprogrammed. Depending on the specifics of the application, this might include all or a subset of the following procedures:

- Setting system parameters:
  - Establish a security password, if desired, requiring Operator to log in (secure in safe file for reference).
  - Establish and start an automatic calibration cycle, if desired.
- Routine Operation:
  - Calibrate the instrument.
  - Choose autoranging or select a fixed range of analysis.
  - Set alarm setpoints, and modes of alarm operation (latching, fail-safe, etc).
- Program/Reprogram the analyzer:
  - Define new applications.
  - Linearize your ranges.

If you choose not to use password protection, the default password is automatically displayed on the password screen when you start up, and you simply press *Enter* for access to all functions of the analyzer.

### 3.2 Using the Data Entry and Function Buttons

**Data Entry Buttons:** The < > buttons select options from the menu currently being displayed on the VFD screen. The selected option blinks.

When the selected option includes a modifiable item, the  $\Delta$   $\nabla$  arrow buttons can be used to increment or decrement that modifiable item.



The **Enter** button is used to accept any new entries on the VFD screen. The **Escape** button is used to abort any new entries on the VFD screen that are not yet accepted by use of the **Enter** button.

Figure 4-1 shows the hierarchy of functions available to the operator via the function buttons. The six functions of the buttons on the analyzer are:

- **Analyze.** This is the normal operating mode. The analyzer monitors the concentration of the sample, displays the percent or parts-per-million of target fluid or contamination, and warns of any alarm conditions.
- **System.** The system function consists of nine subfunctions.

Four of these are for ordinary setup and operation:

- Setup an Auto-Cal
- Assign Passwords
- Log out to secure system
- Initiate a Self-Test

Three of the subfunctions do auxiliary tasks:

- Checking model and software version
- Adjust electronic filter of the signal
- Display more subfunctions
- Display negative readings

Two of these are for programming/reprogramming the analyzer:

- Define fluid applications and ranges (Refer to programming section, or contact factory.)
- Use the Curve Algorithm to linearize output. (Refer to programming section, or contact factory.)
- **Zero.** Used to set up a zero calibration.
- **Span.** Used to set up a span calibration.
- **Alarms.** Used to set the alarm setpoints and determine whether each alarm will be active or defeated, HI or LO acting, latching, and/or fail-safe.
- **Range.** Used to set up three analysis ranges that can be switched automatically with autoranging or used as individual fixed ranges.

Any function can be selected at any time by pressing the appropriate button (unless password restrictions apply). The order as presented in this manual is appropriate for an initial setup.

Each of these functions is described in greater detail in the following procedures. The VFD screen text that accompanies each operation is reproduced, at

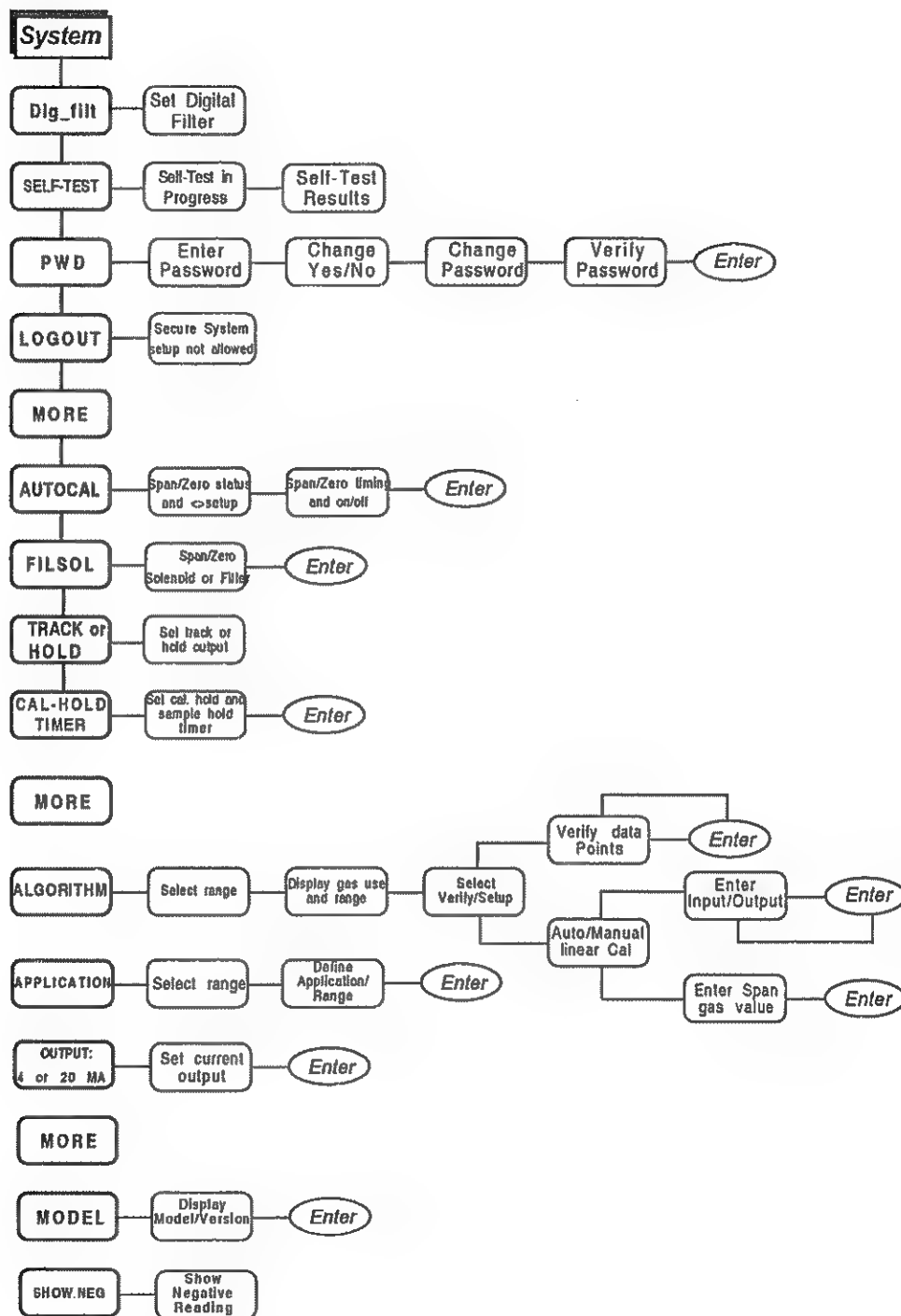


Figure 3-1: Hierarchy of System Functions and Subfunctions

---

the appropriate point in the procedure, in a **Monospaced** type style. Push-button names are printed in *Oblique* type.

### 3.3 The *System* Function

The subfunctions of the *System* function are described below. Specific procedures for their use follow the descriptions:

- **Dig\_Filt**: Adjust how much digital filtering should be on the signal
- **SELF-TEST**: Performs a self-diagnostic test to check the integrity of the power supplies, outputs, detector signal and preamplifier.
- **PWD**: Login security system for accessing to the setup functions.
- **LOGOUT**: Prevents an unauthorized tampering with analyzer settings.
- **AUTOCAL**: Set the automatic calibrated timer schedule for Zero and Span cycling.
- **FILSOL**: Select Span/Zero flag (filter) or Span/Zero solenoid valve for calibration method.
- **TRACK**: Set the system reading to be held or followed by the concentration “fluid or filter” during calibration.
- **CAL-HOLD-TIMER**: Set the timing for calibration holding and timing for the sample reading after return to analyze mode.
- **ALGORITHM**: Linearize the output for nonlinear characteristic.
- **APPLICATION**: Used to define the analysis ranges and application (fluid used).
- **MODEL**: Displays model number and software version.
- **OUTPUT**: 4-20 mA: Adjust 4 and 20 mA output
- **SHOW\_NEG**: Whether to display negative readings or not; affects analog output too. No negative readings is the default.

#### 3.3.1 Setting up an AUTO-CAL

When proper automatic valving is connected, the Analyzer can cycle itself through a sequence of steps that automatically zero and span the instrument.



**Note:** Before setting up an AUTO-CAL, be sure you understand the *Zero* and *Span* functions as described in section 4.4, and follow the precautions given there.

**Note:** If you require highly accurate AUTO-CAL timing, use external AUTO-CAL control where possible. The internal clock in the Model 5000BF is accurate to 2-3 %. Accordingly, internally scheduled calibrations can vary 2-3 % per day.

To setup an Auto-Cal cycle:

Choose *System* from the Function buttons. The VFD will display five subfunctions.

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

Select MORE and press the Enter Key

AUTOCAL FILSOL HOLD  
CAL-HOLD-TIMER MORE

Use < > arrows to blink AUTO-CAL, and press *Enter*. A new screen for ZERO/SPAN set appears.

ZERO in 0d 0h off  
SPAN in 0d 0h off

Press < > arrows to blink ZERO (or SPAN), then press *Enter* again. (You won't be able to set OFF to ON if a zero interval is entered.) A Span Every ... (or Zero Every ...) screen appears.

Zero schedule: OFF  
Day: 0d Hour: 0h

Use  $\Delta \nabla$  arrows to set an interval value, then use < > arrows to move to the start-time value. Use  $\Delta \nabla$  arrows to set a start-time value.

To turn ON the SPAN and/or ZERO cycles (to activate AUTO-CAL): Press *System* again, choose AUTO-CAL, and press *Enter* again. When the ZERO/SPAN values screen appears, use the < > arrows to blink the ZERO (or SPAN) and press *Enter* to go to the next screen. Use < > to select OFF/ON field. Use  $\Delta \nabla$  arrows to set the OFF/ON field to ON. You can now turn these fields ON because there is a nonzero span interval defined.

If instrument is turned off, the next time the instrument is powered, the instrument will automatically perform a calibration cycle after 3 minutes of entering the sample mode if AUTOCAL functions were on prior to shut down.

### 3.3.2 Password Protection

Before a unique password is assigned, the system assigns TAI by default. This password will be displayed automatically. The operator just presses the Enter key to be allowed total access to the instrument's features.

If a password is assigned, then setting the following system parameters can be done only after the password is entered: **alarm** setpoints, assigning a new **password**, **range/application** selections, and **curve algorithm** linearization. (APPLICATION and ALGORITHM are covered in the programming section.) However, the instrument can still be used for analysis or for initiating a self-test without entering the password. To defeat security the password must be changed back to TAI.

**NOTE:** If you use password security, it is advisable to keep a copy of the password in a separate, safe location.

#### 3.3.2.1 Entering the Password

To install a new password or change a previously installed password, you must key in and *ENTER* the old password first. If the default password is in effect, pressing the *ENTER* button will enter the default TAI password for you.

Press *System* to enter the *System* mode.

```
DIG_FILT  AUTO-CAL
PWD      LOGOUT  MORE
```

Use the < > arrow keys to scroll the blinking over to PWD, and press *Enter* to select the password function. Either the default TAI password or AAA placeholders for an existing password will appear on screen depending on whether or not a password has been previously installed.

```
Enter password:
  T A I
```

*or*

```
Enter password:
  A A A
```

The screen prompts you to enter the current password. If you are not using password protection, press *Enter* to accept TAI as the default password. If a password has been previously installed, enter the password using the < > arrow keys to scroll back and forth between letters, and the  $\Delta \nabla$  arrow keys to change the letters to the proper password. Press *Enter* to enter the password.

In a few seconds, you will be given the opportunity to change this password or keep it and go on.

**Change Password?**

<ENT>=Yes    <ESC>=No

Press *Escape* to move on, or proceed as in *Changing the Password*, below.

### 3.3.2.2 Installing or Changing the Password

If you want to install a password, or change an existing password, proceed as above in *Entering the Password*. When you are given the opportunity to change the password:

**Change Password?**

<ENT>=Yes    <ESC>=No

Press *Enter* to change the password (either the default TAI or the previously assigned password), or press *Escape* to keep the existing password and move on.

If you chose *Enter* to change the password, the password assignment screen appears.

**Select new password**

**TAI**

Enter the password using the < > arrow keys to move back and forth between the existing password letters, and the Δ∇ arrow keys to change the letters to the new password. The full set of 94 characters available for password use are shown in the table below.

**Characters Available for Password Definition:**

A	B	C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R	S	T
U	V	W	X	Y	Z	[	¥	]	^
_	`	a	b	c	d	e	f	g	h
i	j	k	l	m	n	o	p	q	r
s	t	u	v	w	x	y	z	{	
}	→	!	"	#	\$	%	&	'	(
)	*	+	,	-	.	/	0	1	2
3	4	5	6	7	8	9	:	;	<
=	>	?	@						

When you have finished typing the new password, press *Enter*. A verification screen appears. The screen will prompt you to retype your password for verification.

Enter PWD To Verify:  
A A A

Use the arrow keys to retype your password and press *Enter* when finished. Your password will be stored in the microprocessor and the system will immediately switch to the *Analyze* screen, and you now have access to all instrument functions.

If all alarms are defeated, the *Analyze* screen appears as:

1.95 ppm SO<sub>2</sub>  
nR1: 0 - 10 Anlz

If an alarm is tripped, the second line will change to show which alarm it is:

1.95 ppm SO<sub>2</sub>  
AL - 1

**NOTE:** If you log off the system using the LOGOUT function in the system menu, you will now be required to re-enter the password to gain access to Alarm, and Range functions.

### 3.3.3 Logging Out

The LOGOUT function provides a convenient means of leaving the analyzer in a password protected mode without having to shut the instrument off. By entering LOGOUT, you effectively log off the instrument leaving the system protected against use until the password is reentered. To log out, press the *System* button to enter the *System* function.

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

Use the <> arrow keys to position the blinking over the LOGOUT function, and press *Enter* to Log out. The screen will display the message:

Protected until  
password entered

### 3.3.4 System Self-Diagnostic Test

The Model 5000BF has a built-in self-diagnostic testing routine. Pre-programmed signals are sent through the power supply, output board, preamp board and sensor circuit. The return signal is analyzed, and at the end of the test the status of each function is displayed on the screen, either as OK or as a number between 1 and 1024. (See *System Self Diagnostic Test* in chapter 4 for number code.) If any of the functions fails, the System Alarm is tripped.

---

**Note:** The sensor will always show failed unless Zero fluid is present in the sampling cell at the time of the SELF-TEST.

The self diagnostics are run automatically by the analyzer whenever the instrument is turned on, but the test can also be run by the operator at will. To initiate a self diagnostic test during operation:

Press the *System* button to start the *System* function.

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

Use the < > arrow keys again to move the blinking to the SELF-TEST and press *Enter*. The screen will follow the running of the diagnostic.

RUNNING DIAGNOSTIC  
Testing Preamp – Cell I

When the testing is complete, the results are displayed.

Power: OK Analog: OK  
Cell: 2 Preamp: 3

The module is functioning properly if it is followed by OK. A number indicates a problem in a specific area of the instrument. Refer to Chapter 5 *Maintenance and Troubleshooting* for number-code information. The results screen alternates for a time with:

Press Any Key  
To Continue...

Then the analyzer returns to the initial System screen.

### 3.3.5 The Model Screen

Move the < > arrow key to MORE and press *Enter*. With MODEL blinking, press *Enter*. The screen displays the manufacturer, model, and software version information.

### 3.3.6 Checking Linearity with ALGORITHM

From the *System* Function screen, select ALGORITHM, and press *Enter*.

sel mg to set algo:  
-> 01 02 03 <-

Use the < > keys to select the range: 01, 02, or 03. Then press *Enter*.

Fluid Use: S02  
Range: 0 – 10%

Press *Enter* again.

Algorithm setup:  
VERIFY SET UP

Select and *Enter* VERIFY to check whether the linearization has been accomplished satisfactorily.

Dpt INPUT OUTPUT  
0 0.00 0.00

The leftmost digit (under Dpt) is the number of the data point being monitored. Use the  $\Delta \nabla$  keys to select the successive points.

The INPUT value is the input to the linearizer. It is the simulated output of the analyzer. **You do not need to actually flow fluid.**

The OUTPUT value is the output of the linearizer. It should be the ACTUAL concentration of the span fluid being simulated.

If the OUTPUT value shown is not correct, the linearization must be corrected. Press *ESCAPE* to return to the previous screen. Select and *Enter* SET UP to Calibration Mode screen. (set-up will not work without a PC being connected to the analyzer)

Select algorithm  
mode : AUTO

There are two ways to linearize: AUTO and MANUAL: The auto mode requires as many calibration fluids as there will be correction points along the curve. The user decides on the number of points, based on the precision required.

The manual mode only requires entering the values for each correction point into the microprocessor via the front panel buttons. Again, the number of points required is determined by the user.

### 3.3.7 Digital Filter Setup

The 5000BF has the option of decreasing or increasing the amount filtering on the signal. This feature enhances the basic filtering done by the analog circuits by setting the amount of digital filtering effected by the microprocessing. To access the digital filter setup, you must:

1. Press the System key to start the System function

DIG\_FILT      SELF-TEST  
PWD LOGOUT      MORE

2. DIG\_FILT will flash, press the ENTER key,

Weight of digital  
Filter: 9

3. The number on the second row will flash and can be set by using the Up or Down arrow keys.

The settings go from zero, no digital filtering, to 10, maximum digital filtering. The default setting is 8 and that should suffice for most applications. In some applications where speeding the response time with some trade off in noise is of value, the operator could decrease the number of the digital filter. In applications where the signal is noisy, the operator could switch to a higher number; the response time is slowed down though.

90% response time on the different settings to a step input is shown below. This response time does not include the contributions of the bench sampling system and the preamplifier near the detector.

**Setting    90% Response time  
(seconds)**

0	4.5
1	4.5
2	5.0
3	5.0
4	5.5
5	7.0
6	9.0
7	14.0
8	25.0
9	46.0
10	90.0

At a setting of "zero", the response time is purely set by the electronics to 4.5 seconds. The numbers above can and will change depending on application and they merely serve to illustrate the effect of the digital filter.

### 3.3.8 Filter or Solenoid Setup

The 5000BF can be spanned or zeroed by calibration fluids or by optical filters. The proper calibration method should be set at the factory. To access the Filter or Solenoid Flags, you must:

1. Press the System key to start the System function:

```
DIG_FILT  SELF-TEST
PWD  LOGOUT  MORE
```

2. Using the Right or Left arrow keys, select MORE and press Enter. The second System screen appears:

```
AUTOCAL  FILSOL  TRACK
CAL-HOLD-TIMER  MORE
```

3. Select FILSOL using the Right or Left arrow keys and press Enter to start the method of calibration function.

```
Set fil/sol for cal
Span: FIL Zero: SOL
```

There are two flag options: zero and/or span flags are chosen at time of purchase, one for Zero calibration and the other for Span located in the Detector housing. To move between the Zero and the Span flags, use the Right or Left arrow keys. FIL means that a filter will do this particular calibration. SOL means that the signal to activate a fluid solenoid is enabled. To toggle between the SOL and FIL options, use the Up and Down arrow keys.

The connections to drive the filter and the solenoid are found on a strip terminal located on the interface board. The connections are described in section 5-6 of the maintenance section of the manual.

### 3.3.9 Hold/Track Setup

The 5000BF has ability to disable the analog outputs and freeze the display while undergoing a scheduled or remote calibration. **The 5000BF will track changes in the concentration if calibration is started through the front panel.** To setup this feature, the operator must:

1. Press the System key to start the System function:

```
DIG_FILT  SELF-TEST
PWD  LOGOUT  MORE
```

2. Using the Right or Left arrow keys, select MORE and press Enter. The Second System screen appears:



---

AUTOCAL FILSOL TRACK  
CAL-HOLDER-TIMER MORE

or

AUTOCAL FILSOL HOLD  
CAL-HOLD-TIMER MORE

3. The option on the right of the first row can be set to TRACK or HOLD by using the UP or Down keys. By selecting the TRACK option, the analog outputs are enabled and with the display will track the concentration changes while the instrument is undergoing scheduled or remote calibration (either zero or span). By selecting the HOLD option, the analog outputs and display are disabled and will not track the concentration changes while the instrument is undergoing scheduled or remote calibration (either zero or span). In the HOLD option, the analog outputs and display will freeze on the last reading before entering calibration.

The analog outputs are both 0 to 1 volt outputs and both 4 to 20 mA outputs.

### 3.3.10 Calibration/Hold Timer Setup

This Calibration Timer lets the operator adjust the time the instrument purges the calibration fluid prior to actually start the calibration computations. The Sample timer lets the operator adjust the time the instrument purges sample fluid after finishing a calibration before it lets the analog outputs and display track the change in concentration.

This function and the TRACK/HOLD feature will prevent false alarms while performing remote or autoscheduled calibrations. These functions are not applicable if the calibration is initiated through the front panel. To enter the Calibration/Hold Timer function, you must:

1. Press the System key to start the System function:

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

2. Using the Right or Left arrow keys, select MORE and press Enter: The Second System screen appears:

AUTOCAL FILSOL TRACK  
CAL-HOLD-TIMER MORE

or

---

AUTOCAL FILSOL HOLD  
CAL-HOLD-TIMER MORE

3. Select with the Right or Left keys CAL-HOLD-TIMER, and press the Enter key to access this function menu:

Calbrt hold: 3 min  
Sample hold: 1 min

The calibration hold time is set on the first row, while the sample hold time is set on the second row. To select one or the other, use the Right or Left keys. To modify the time of either timer, use the Up or Down keys. The time is in the minutes.

### 3.3.11 Analog 4 to 20 mA Output Calibration

This function will let the operator calibrate the 4 to 20 mA analog output to match the display reading. A DMM configured as a DC ammeter is needed. The DMM should be connected across the output terminals of the 4 to 20 mA output to monitor the output current. To enter the 4 to 20 mA output adjust function, you must:

1. Press the System key to start the System function:

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

2. Using the Right or Left arrow keys, select MORE and press Enter. The second System screen appears:

AUTOCAL FILSOL TRACK  
CAL-HOLD-TIMER MORE

or

AUTOCAL FILSOL HOLD  
CAL-HOLD-TIMER MORE

3. Using the Right or the Left arrow keys, select MORE and press Enter. The third System screen appears:

ALGORITHM APPLICATION  
MODEL OUTPUT: 4 MA

or

ALGORITHM APPLICATION  
MODEL OUTPUT: 20 MA

OUTPUT: 4 MA and OUTPUT: 20 MA can be toggled by moving on that field and pressing the Up or Down key. 4 mA output should be calibrated first and 20 mA output afterwards.

4. Select OUTPUT: 4 MA and press the Enter key

Use UP/DOWN arrow to

Adjust 4 ma:            250

The number on the second row is the setpoint of the 4 mA output. It is analogous to a potentiometer wiper. The number can be set anywhere from 0 to 500. The default is 250, in the middle. At the default setting, the output should be very close to 4 mA. If not, slowly adjust the number using the Up or the Down keys until DMM reads 4.00 mA. Press the Enter key when done.

5. Now select OUTPUT: 20 MA and press the Enter key. A screen similar to the one above will appear and the DMM should read close to 20 mA. If not, slowly adjust the number using the Up or Down key until DMM reads 20.0 mA. Press the Enter key when done.

The range of adjustment is approximately  $\pm 10\%$  of scale ( $\pm 1.6$  ma). Since the 4 to 20 mA output is tied to the 0 to 1 volt output, this function can be used to calibrate the 0 to 1 volt output, if the 4 to 20 mA output is not used. By using a digital Volt meter on the 0-1 Volt output.

### 3.3.12 Model

This selection in the System menu flashes for a few seconds the model number and the software version installed in this instrument.

### 3.3.13 Show Negative

The analyzer defaults to not to show negative readings on the analyze mode only. This affects the analog outputs too by pressing the UP or DOWN key, the analyzer can be set to display negative readings, on the SHOW\_NEG field of the system menu.

## 3.4 The Zero and Span Functions

The Model 5000BF can have as many as three analysis ranges plus a special calibration range (Cal Range). Calibrating any one of the ranges will automatically calibrate the other ranges

**CAUTION:** Always allow 4-5 hours warm-up time before calibrating, if your analyzer has been disconnected from its

***power source. This does not apply if the analyzer was plugged in but was in STANDBY.***

The analyzer is calibrated using zero, and span fluids.

**Note:** Shut off the fluid pressure before connecting it to the analyzer, and be sure to limit pressure to 40 psig or less when turning it back on.

Readjust the fluid pressure into the analyzer until the flowrate through the Sample Cell settles between 50 to 200 cc/min (approximately 0.1 to 0.4 SCFH).

**Note:** Always keep the calibration fluid flow as close to the flowrate of the sample fluid as possible



### 3.4.1 Zero Cal

The *Zero* function on the menu is used to enter the zero calibration function. Zero calibration can be performed in either the automatic or manual mode.

Make sure the zero fluid is flowing to the instrument. If you get a CELL CANNOT BE BALANCED message while zeroing skip to section 4.4.1.3.

#### 3.4.1.1 Auto Mode Zeroing

Observe the precautions in sections 4.4 and 4.4.1, above. Press *Zero* to enter the zero function mode. The screen allows you to select whether the zero calibration is to be performed automatically or manually. Use the  $\Delta\nabla$  arrow keys to toggle between AUTO and MAN zero setting. Stop when AUTO appears, blinking, on the display.

Select zero  
mode: AUTO

Press *Enter* to begin zeroing.

####.## %      S02  
Slope=#.### C—Zero

The beginning zero level is shown in the upper left corner of the display. As the zero reading settles, the screen displays and updates information on Slope= in percent/second (unless the Slope starts within the acceptable zero range and does not need to settle further). The system first does a coarse zero, shown in the lower right corner of the screen as C—Zero, for 3 min, and then does a fine zero, and displays F—Zero, for 3 min.

Then, and whenever Slope is less than 0.01 for at least 3 min, instead of Slope you will see a countdown: 9 Left, 8 Left, and so fourth. These are software steps in the zeroing process that the system must complete, AFTER settling, before it can go back to *Analyze*. Software zero is indicated by S-Zero in the lower right corner.

```
####.## % S02
4 Left=#.### S-Zero
```

The zeroing process will automatically conclude when the output is within the acceptable range for a good zero. Then the analyzer automatically returns to the *Analyze* mode.

#### 3.4.1.2 Manual Mode Zeroing

Press *Zero* to enter the *Zero* function. The screen that appears allows you to select between automatic or manual zero calibration. Use the  $\Delta V$  keys to toggle between AUTO and MAN zero settling. Stop when MANUAL appears, blinking, on the display.

```
Select zero
mode:  MANUAL
```

Press *Enter* to begin the zero calibration. After a few seconds the first of three zeroing screens appears. The number in the upper left hand corner is the first-stage zero offset. The microprocessor samples the output at a predetermined rate.

```
####.## % S02
Zero adj : 2048 C-Zero
```

The analyzer goes through C-Zero, F-Zero, and S-Zero. During C-Zero and F-Zero, use the  $\Delta V$  keys to adjust displayed Zero adj: value as close as possible to zero. Then, press *Enter*.

S-Zero starts. During S-Zero, the Microcontroller takes control as in *Auto Mode Zeroing*, above. It calculates the differences between successive samplings and displays the rate of change as Slope= a value in parts per million per second (ppm/s).

```
####.## % S02
Slope=#.### S-Zero
```

Generally, you have a good zero when Slope is less than 0.05 ppm/s for about 30 seconds.

Once zero settling completes, the information is stored in the analyzer's memory, and the instrument automatically returns to the *Analyze* mode.

#### 3.4.1.3 Cell Failure

Detector failure in the 5000BF is usually associated with inability to zero the instrument with a reasonable voltage differential between the reference and measure voltages. If this should ever happen, the 5000BF system alarm trips, and the LCD displays a failure message.

**Detector cannot be balanced  
Check your zero fluid**

Before optical balancing:

- Check your zero fluid to make sure it is within specifications.
- Check for leaks downstream from the Sample Cell, where contamination may be leaking into the system.
- Check flowmeter to ensure that the flow is no more than 200 SCCM
- Check temperature controller board.
- Check fluid temperature.
- Check the Sample Cell for dirty windows.

If none of the above, proceed to perform an optical balance as described in section 5.

#### 3.4.2 Span Cal

The *Span* function on the menu is used to span calibrate the analyzer. Span calibration can be performed in either the automatic or manual mode.

Make sure the span fluid is flowing to the instrument.

##### 3.4.2.1 Auto Mode Spanning

Observe all precautions in sections 3.4 and 3.4.2, above. Press *Span* to enter the span function. The screen that appears allows you to select whether the span calibration is to be performed automatically or manually. Use the  $\Delta V$  arrow keys to toggle between AUTO and MAN span settling. Stop when AUTO appears, blinking, on the display.

**Select span  
mode: AUTO**

Press *Enter* to move to the next screen.

Span Val: 20.00 %  
<ENT> To begin span

Use the <> arrow keys to toggle between the span concentration value and the units field (%/ppm). Use the  $\Delta\nabla$  arrow keys change the value and/or the units, as necessary. When you have set the concentration of the span fluid you are using, press *Enter* to begin the Span calibration.

####.##% S02  
Slope=#.## Span

The beginning span value is shown in the upper left corner of the display. As the span reading settles, the screen displays and updates information on Slope. Spanning automatically ends when the span output corresponds, within tolerance, to the value of the span fluid concentration. Then the instrument automatically returns to the analyze mode.

### 3.4.2.2 Manual Mode Spanning

Press *Span* to start the *Span* function. The screen that appears allows you to select whether the span calibration is to be performed automatically or manually.

Select span  
mode: MANUAL

Use the  $\Delta\nabla$  keys to toggle between AUTO and MAN span settling. Stop when MAN appears, blinking, on the display. Press *Enter* to move to the next screen.

Span Val: 20.00 %  
<ENT> To begin span

Use the <> arrow keys to toggle between the span concentration value and the units field (%/ppm). Use the  $\Delta\nabla$  arrow keys change the value and/or the units, as necessary. When you have set the concentration of the span fluid you are using, press *Enter* to begin the Span calibration.

Press *Enter* to enter the span value into the system and begin the span calibration.

Once the span has begun, the microprocessor samples the output at a predetermined rate. It calculates the difference between successive samplings and displays this difference as Slope on the screen. It takes several seconds for

the first Slope value to display. Slope indicates rate of change of the Span reading. It is a sensitive indicator of stability.

```
####.##%      S02
Slope=#.###   Span
```

When the Span value displayed on the screen is sufficiently stable, press *Enter* (Generally, when the Span reading changes by 1 % or less of the range being calibrated for a period of ten minutes it is sufficiently stable.) Once *Enter* is pressed, the Span reading changes to the correct value. The instrument then automatically enters the *Analyze* function.

### 3.4.3 Offset Function

This software when installed in the 5000BF instruments provides a way to enter an offset on the zero operation of the analyser. This is useful when the instrument is zeroed in some inert fluid such as Nitrogen or Argon, but the background fluid of the process is different. If the background fluid of the process is different than the zero calibration fluid being used, the reading will have an offset that will be constant throughout its working range. Thus, the need to provide an offset when the instrument is being zeroed.

#### *How to access the offset function:*

To access this function, the instrument zero mode must be entered by pushing the Zero key on the front panel of the control unit. The VFD display will show the following menu selection:

```
Select zero
mode: AUTO
```

or

```
Select zero
mode: MAN
```

Select whether you want the instrument to do an automatic or manual zero. If you do an automatic zero, the instrument does the zero by itself. If you do a manual zero you must manually enter inputs to the instrument to accomplish the zero, see in the corresponding section of the manual on how these two functions differ.

When the Enter key is pressed, the following menu will appear:

```
Zero off:  0.0 ppm
<ENT> to begin Zero
```



---

The offset value can be modified by using the Up/Down keys. Next section shows how to select this value. Suffice to say that whatever value you enter, will be automatically added to the reading. Thus, if you entered -0.1 ppm, at the end of the zero the display will show -0.1 ppm.

Once the Enter key is pressed the instrument enters the zero mode. If you chose AUTO zero mode, the instrument will do the work of bringing the reading back to zero plus the offset value that was entered. If you chose MANual zero mode, then you must enter input to the instrument as explained in the corresponding section of the manual but with one difference: instead of bringing the display to read zero, you must make the display read zero plus the value entered as offset.

***How the offset value is selected:***

To find out what the offset value should be, the intended zero calibration fluid and the a mix of the process background fluid must be procured. This of course assumes that the zero fluid and the process background fluid are very different and that an offset will occur.

1. Let the intended zero calibration fluid flow through the 5000BF sample cell (this assumes that you have started up you system as recommended by the manual or technical personnel) and do a zero on the instrument. Leave the offset set to zero value.
2. At the end of the zero function, make sure the analyser reads zero.
3. Flow a zero level of the process background fluid mix through the 5000BF sample cell on the Analyse mode. Wait for the reading to become stable. Write the reading down. Change the sign of the reading. This is the offset to be entered.
4. Do a manual run to check. Reintroduce the zero calibration fluid. Start a zero on the analyser but this time enter the offset value.
5. At the end of the zero function, check that the instrument reads the entered offset.
6. Reintroduce the process background fluid mix to the 5000BF sample cell in the Analyse mode. It should read close to zero once the reading is stable (+/- 1% error of full scale).

***Spanning the 5000BF:***

Since the instrument might be spanned with background fluid the same as the zero calibration fluid, the span value to be entered should be the span concentration plus the offset value (if the offset value has a minus sign then algebraically it becomes a subtraction).

### 3.5 The Alarms Function

The Model 5000BF is equipped with two fully adjustable set points concentration with two alarms and a system failure alarm relay. Each alarm relay has a set of form "C" contacts rated for 3 amperes resistive load at 250 V ac. See Figure in Chapter 2, *Installation* and/or the Interconnection Diagram included at the back of this manual for relay terminal connections.

The system failure alarm has a fixed configuration described in chapter 2 *Installation*.

The concentration alarms can be configured from the front panel as either *high* or *low* alarms by the operator. The alarm modes can be set as *latching* or *non-latching*, and either *failsafe* or *non-failsafe*, or, they can be *defeated* altogether. The setpoints for the alarms are also established using this function.

Decide how your alarms should be configured. The choice will depend upon your process. Consider the following four points:

1. Which if any of the alarms are to be high alarms and which if any are to be low alarms?

Setting an alarm as HIGH triggers the alarm when the contaminant concentration rises above the setpoint. Setting an alarm as LOW triggers the alarm when the contaminant concentration falls below the setpoint.

Decide whether you want the alarms to be set as:

- Both high (high and high-high) alarms, or
- One high and one low alarm, or
- Both low (low and low-low) alarms.

2. Are either or both of the alarms to be configured as failsafe?

In failsafe mode, the alarm relay de-energizes in an alarm condition. For non-failsafe operation, the relay is energized in an alarm condition. You can set either or both of the concentration alarms to operate in failsafe or non-failsafe mode.

3. Are either of the alarms to be latching?

In latching mode, once the alarm or alarms trigger, they will remain in the alarm mode even if process conditions revert back to non-alarm conditions. This mode requires an alarm to be recognized before it can be reset. In the non-latching mode, the alarm status will terminate when process conditions revert to non-alarm conditions.

4. Are either of the alarms to be defeated?

The defeat alarm mode is incorporated into the alarm circuit so that maintenance can be performed under conditions which would normally activate the alarms.

The defeat function can also be used to reset a latched alarm. (See procedures, below.)

If you are using password protection, you will need to enter your password to access the alarm functions. Follow the instructions in section 3.3.3 to enter your password. Once you have clearance to proceed, enter the *Alarm* function.

Press the *Alarm* button on the front panel to enter the *Alarm* function.

Use the  $\Delta \nabla$  keys to choose between % or ppm units. Then press *Enter* to move to the next screen.

AL1: 1000 ppm HI  
Dft:N Fs:N Ltch:N

Five parameters can be changed on this screen:

- Value of the alarm setpoint, AL1: ####
- Out-of-range direction, HI or LO
- Defeated? Dft:Y/N (Yes/No)
- Failsafe? Fs:Y/N (Yes/No)
- Latching? Ltch:Y/N (Yes/No).
- To define the setpoint, use the < > arrow keys to move the blinking over to AL1: ####. Then use the  $\Delta \nabla$  arrow keys to change the number. Holding down the key speeds up the incrementing or decrementing.
- To set the other parameters use the < > arrow keys to move the blinking over to the desired parameter. Then use the  $\Delta \nabla$  arrow keys to change the parameter.
- Once the parameters for alarm 1 have been set, press *Alarms* again, and repeat this procedure for alarm 2 (AL2).
- To reset a latched alarm, go to Dft-- and then press either  $\Delta$  two times or  $\nabla$  two times. (Toggle it to Y and then back to N.)

–OR –

Go to Ltch-- and then press either  $\Delta$  two times or  $\nabla$  two times. (Toggle it to N and back to Y.)

### 3.6 The Range Select Function

The *Range* function allows you to manually select the concentration range of analysis (MANUAL), or to select automatic range switching (AUTO).

In the MANUAL screen, you are further allowed to define the high and low (concentration) limits of each Range, and select a single, fixed range to run.

**CAUTION:** *If this is a linearized application, the new range must be within the limits previously programmed using the System function, if linearization is to apply throughout the range. Furthermore, if the limits are too small a part (approx 10 % or less) of the originally linearized range, the linearization will be compromised.*

#### 3.6.1 Manual (Select/Define Range) Screen

The Manual range-switching mode allows you to select a single, fixed analysis range. It then allows you to redefine the upper and lower limits, for the range.

Press *Range* key to start the Range function.

Select range  
mode: MANUAL

If above screen displays, use the  $\Delta \nabla$  arrow keys to Select MANUAL, and press *Enter*.

Select range to run  
→ 01 02 03 CAL←

Use the < > keys to select the range: 01, 02, 03, or CAL. Then press *Enter*.

Fluid use: S02  
Range: 0 – 10 %

Use the < > keys to toggle between the Range: low-end field and the Range: high-end field. Use the  $\Delta \nabla$  keys to change the values of the fields.

Press *Escape* to return to the previous screen to select or define another range.

Press *Enter* to return the to the *Analyze* function.

### 3.6.2 Auto Screen

Autoranging will automatically set to the application that has at least two ranges setup with the same fluides.

In the autoranging mode, the microprocessor automatically responds to concentration changes by switching ranges for optimum readout sensitivity. If the upper limit of the operating range is reached, the instrument automatically shifts to the next higher range. If the concentration falls to below 85% of full scale of the next lower range, the instrument switches to the lower range. A corresponding shift in the DC concentration output, and in the range ID outputs, will be noticed.

The autoranging feature can be overridden so that analog output stays on a fixed range regardless of the contaminant concentration detected. If the concentration exceeds the upper limit of the range, the DC output will saturate at 1 V dc (20 mA at the current output).

However, the digital readout and the RS-232 output of the concentration are unaffected by the fixed range. They continue to read beyond the full-scale setting until amplifier saturation is reached. Below amplifier saturation, the overrange readings are accurate UNLESS the application uses linearization over the selected range.

The concentration ranges can be redefined using the *Range* function Manual screen, and the application fluides can be redefined using the *System* function, if they are not already defined as necessary.

**CAUTION: Redefining applications or ranges might require relinearization and/or recalibration.**

To setup automatic ranging:

Press *Range* key to start the Range function.

Select range  
mode : AUTO

If above screen displays, use the  $\Delta V$  arrow keys to Select AUTO, and press *Enter*.

Press *Escape* to return to the previous Analyze Function.

### 3.6.3 Precautions

The Model 5000BF allows a great deal of flexibility in choosing ranges for automatic range switching. However, there are some pitfalls that are to be avoided

Ranges that work well together are:

- Ranges that have the same lower limits but upper limits that differ by approximately an order of magnitude
- Ranges whose upper limits coincide with the lower limits of the next higher range
- Ranges where there is a gap between the upper limit of the range and the lower limit of the next higher range.

Range schemes that are to be avoided include:

- Ranges that overlap
- Ranges whose limits are entirely within the span of an adjoining range.
- Ranges where the zero is suppressed, is 1-10, 1-100, etc, however, 80-100, 90-100 is ok where the zero fluid is actually 100% concentration and the calibration is inverted.

Figure 3-2 illustrates these schemes graphically.

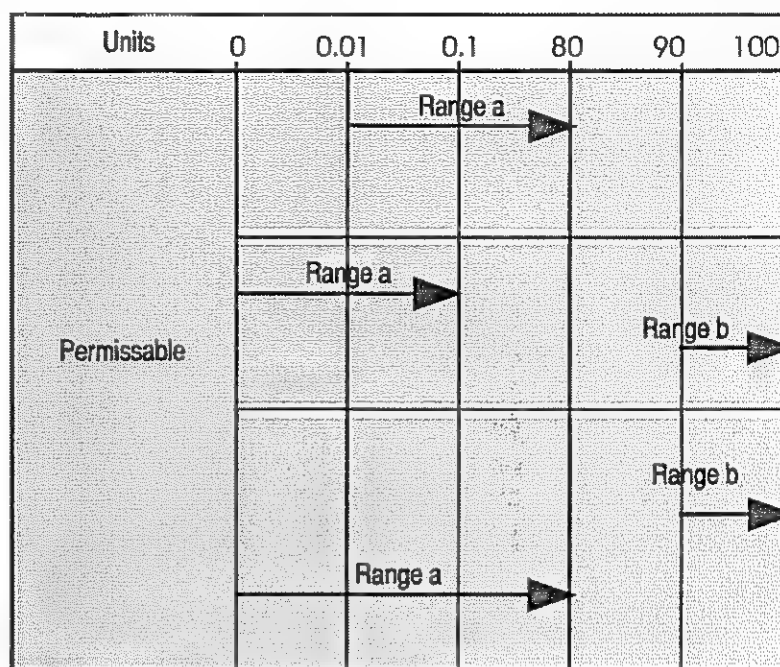


Figure 3-2: Examples of Autoranging Schemes

### 3.7 The *Analyze* Function

Normally, all of the functions automatically switch back to the *Analyze* function when they have completed their assigned operations. Pressing the *Escape* button in many cases also switches the analyzer back to the *Analyze* function. Alternatively, you can press the *Analyze* button at any time to return to analyzing your sample.

The *Analyze* function screen shows the impurity concentration and the application fluides in the first line, and the range in the second line. In the lower right corner, the abbreviation *Anlz* indicates that the analyzer is in the *Analyze* mode. If there is an \* before the *Anlz*, it indicates that the range is linearized.

1.95 ppm S02  
R1:Ø -10 \*Anlz

If the concentration detected is overrange, the first line of the display blinks continuously.

### 3.8 Programming

**CAUTION:** *The programming functions of the Set Range and Curve Algorithm screens are configured at the factory to the users application specification. These functions should only be reprogrammed by trained, qualified personnel.*

To program, you must:

1. Enter the password, if you are using the analyzer's password protection capability.
2. Connect a computer or computer terminal capable of sending an RS-232 signal to the analyzer RS-232 connector. (See chapter 2 *Installation* for details). Send the rp command to the analyzer.
3. Press the *System* button to start the *System* function.

DIG\_FILT SELF-TEST  
PWD LOGOUT MORE

Use the < > arrow keys to blink MORE, then press *Enter*.

AUTOCAL FILSOLL HOLD  
CAL-HOLD-TIMER MORE

Select MORE and press ENTER one more time

ALGORITHM APPLICATION  
MORE OUTPUT: 4MA

Now you will be able to select the APPLICATION and ALGORITHM set-up functions.

#### 3.8.1 The Set Range Screen

The Set Range screen allows reprogramming of the three analysis ranges and the calibration range (background fluid, low end of range, high end of range, and % or ppm units). Original programming is usually done at the factory according to the customer's application. It must be done through the RS-232 port using a computer running a terminal emulation program.

**Note:** It is important to distinguish between this *System* programming subfunction and the *Range* button function, which is an operator control. The Set Range Screen of the *System* function allows the user to DEFINE the upper and lower limits of a range AND the application of the range. The *Range* button



function only allows the user to select or define the limits, or to select the application, but not to define the application.

Normally the Model 5000BF is factory set to default to manual range selection, unless it is ordered as a single-application multiple-range unit (in which case it defaults to autoranging). In either case, autoranging or manual range selection can be programmed by the user.

In the autoranging mode, the microprocessor automatically responds to concentration changes by switching ranges for optimum readout sensitivity. If the upper limit of the operating range is reached, the instrument automatically shifts to the next higher range. If the concentration falls to below 85% of full scale of the next lower range, the instrument switches to the lower range. A corresponding shift in the DC concentration output, and in the range ID outputs, will be noticed.

The autoranging feature can be overridden so that analog output stays on a fixed range regardless of the contaminant concentration detected. If the concentration exceeds the upper limit of the range, the DC output will saturate at 1 V dc (20 mA at the current output).

However, the digital readout and the RS-232 output of the concentration are unaffected by the fixed range. They continue to read beyond the full-scale setting until amplifier saturation is reached. Below amplifier saturation, the overrange readings are accurate UNLESS the application uses linearization over the selected range.

To program the ranges, you must first perform the four steps indicated at the beginning of section 3.8 *Programming*. You will then be in the second *System* menu screen

```

ALGORITHM      APPLICATION
MORE           OUTPUT: 4MA

```

Use the < > arrow keys again to move the blinking to APPLICATION and press *Enter*.

```

Sel rng to set appl:
-> 01 02 03 CAL <-

```

Use the  $\Delta \nabla$  arrow keys to increment/decrement the range number to 01, 02, 03, or CAL, and press *Enter*.

```

Fluid Name *****
FR:0  TO:10 %

```

Use the < > arrow keys to move to Fluid Name, FR: (from—lower end of range), TO: (to—upper end of range), and PPM or %.

---

Use the  $\Delta \nabla$  arrow keys to increment the respective parameters as desired. Press *Enter* to accept the values and return to *Analyze* mode. (See note below.) Repeat for each range you want to set.

**Note:** The ranges must be increasing from low to high, for example, if Range 1 is set to 0–10 % and Range 2 is set to 0–100 %, then Range 3 cannot be set to 0–50 % since that makes Range 3 lower than Range 2.

Ranges, alarms, and spans are always set in either percent or ppm units, as selected by the operator, even though all concentration-data outputs change from ppm to percent when the concentration is above 9999 ppm.

**Note:** When performing analysis on a fixed range, if the concentration rises above the upper limit as established by the operator for that particular range, the output saturates at 1 V dc (or 20 mA). However, the digital readout and the RS-232 output continue to read regardless of the analog output range.

To end the session, send:

st<enter>

st<enter>

to the analyzer from the computer.

### 3.8.2 The Curve Algorithm Screen

The Curve Algorithm is a linearization method. It provides from 1 to 9 intermediate points between the ZERO and SPAN values, which can be normalized during calibration, to ensure a straight-line input/output transfer function through the analyzer.

Each range is linearized individually, as necessary, since each range will usually have a totally different linearization requirement.

To linearize the ranges, you must first perform the four steps indicated at the beginning of section 3.8 *Programming*. You will then be in the second *System* menu screen.

#### 3.8.2.1 Manual Mode Linearization

To linearize manually, you must have previous knowledge of the nonlinear characteristics of your fluids. You enter the value of the differential between the actual concentration and the apparent concentration (analyzer output). TAI has tabular data of this type for a large number of fluids, which it makes available to customers on request. See Appendix for ordering information. To enter data:

From the *System Functions* Screen—

1. Use < > to select *ALGORITHM* , and *Enter*.
2. Select and *Enter* *SETUP*.
3. *Enter* *MANUAL* from the Calibration Mode Select screen.

Dpt	INPUT	OUTPUT
0	0.00	0.00

The data entry screen resembles the verify screen, but the fluid values can be modified and the data-point number cannot. Use the < > keys to toggle between the INPUT and OUTPUT fields. Use the  $\Delta \nabla$  keys to set the value for the lowest concentration into the first point. Then press *Enter*.

After each point is entered, the data-point number increments to the next point. Moving from the lowest to the highest concentration, use the  $\Delta \nabla$  keys to set the proper values at each point.

Dpt	INPUT	OUTPUT
1	0.00	0.00

Repeat the above procedure for each of the data points you are setting (up to nine points: 0-8). Set the points in unit increments. Do not skip numbers. The linearizer will automatically adjust for the number of points entered.

When you are done, Press *ESCAPE*. The message, Completed. Wait for calculation, appears briefly, and then the main *System* screen returns.

To end the session, send:

st<enter>

st<enter>

to the analyzer from the computer.

### 3.8.2.2 Auto Mode Linearization

To linearize in the Auto Mode, you must have on hand a separate calibration fluid for each of the data points you are going use in your linearization. First, the analyzer is zeroed and spanned as usual. Then, each special calibration fluid, for each of the intermediate calibration points, is flowed, in turn, through the sensor. As each fluid flows, the differential value for that intermediate calibration point is entered from the front panel of the analyzer.

**Note:** The span fluid used to span the analyzer must be >90% of the range being analyzed.

---

Before starting linearization, perform a standard calibration. See section 4.4. To enter data:

From the *System Functions* screen—

1. Use < > to select *ALGORITHM* , and *Enter*.
2. Select and *Enter* *SETUP*.
3. *Enter* *AUTO* from the *Calibration Mode Select* screen.

The *Auto Linearize Mode* data entry screen appears.

19.5 ppm SO2  
Input(0) :20.00

5. Use the  $\Delta \nabla$  keys to set the proper value of calibration fluid, and *Enter*. Repeat this step for each cal-point number as it appears in the Input (x) parentheses.
6. Repeat step 5 for each of the special calibration fluids, from the lowest to the highest concentrations. Press *Escape* when done.

To end the session, send:

st<enter>

st<enter>

to the analyzer from the computer.

## Maintenance

---



Aside from normal cleaning and checking for leaks at the gas connections, routine maintenance is limited to replacing filter elements and fuses, and recalibration.



**WARNING:** SEE WARNINGS ON THE TITLE PAGE OF THIS MANUAL.

### 4.1 Fuse Replacement

The 5000BF requires two 5 x 20 mm, 6.3 A, F type (Fast Blow) fuses.

The fuses are located inside the main housing on the Electrical Connector Panel, as shown in Figure 4-3. To replace a fuse:

1. Disconnect the Unit from its power source.
2. Place a small screwdriver in the notch in the fuse holder cap, push in, and rotate 1/4 turn. The cap will pop out a few millimeters. Pull out the fuse cap and fuse, as shown in Figure 4-1

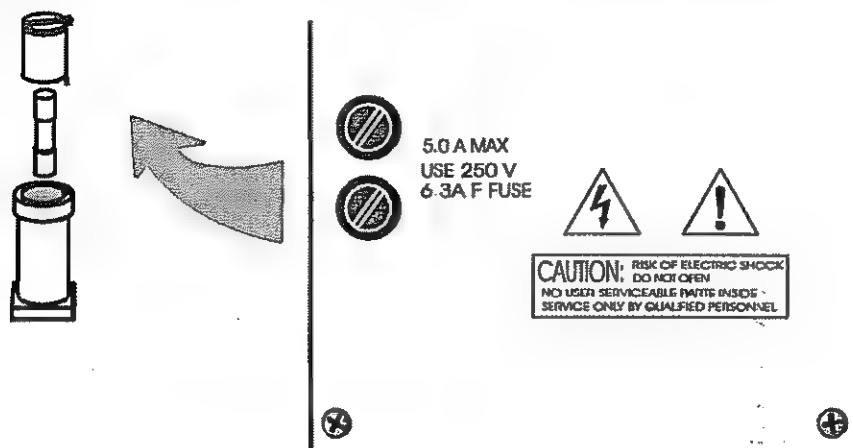


Figure 4-1: Removing Fuse Block Cap and Fuse from Housing

2. Replace fuse by reversing process in step 1.

## 4.2 System Self Diagnostic Test

NOTE: Always run self diagnostic with the intended zero fluid.

1. Press the *System* button to enter the system mode.
2. Use the < > arrow-keys to move to *More*, and press *Enter*.
3. Use the < > arrow keys to move to *Self-Test*, and press *Enter*.

The following failure codes apply:

Table 4-1: Self Test Failure Codes

### Power

0	OK
1	5 V Failure
2	15 V Failures
3	Both Failed

### Analog

0	OK
1	DAC A (0-1 V Concentration)
2	DAC B (0-1 V Range ID)
3	Both Failed

**Preamp**

0 OK  
 >0 means that some of the ten gains of the amplifier have a large offset. The number is a code that tells which of the ten gains have the large offset.

**Cell (detector)**

0 OK  
 >0 means that the analyzer failed to balance the measuring and the reference signals, the larger the number the farther off they were.

**4.3 Major Internal Components**

The major components in the Control Unit are shown in Figure 4-3.

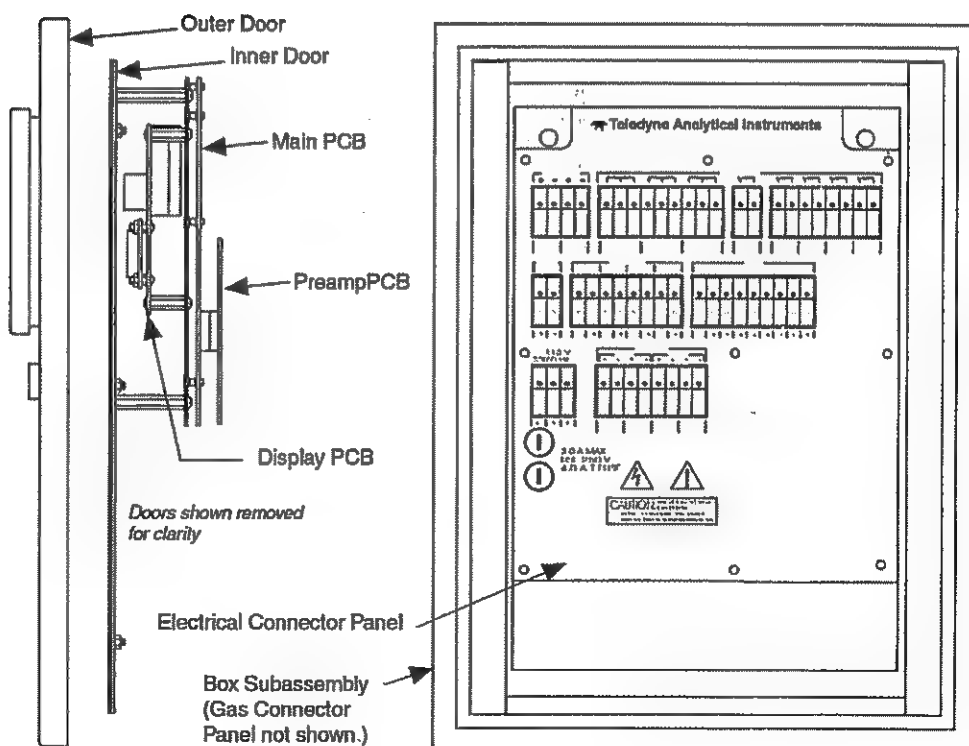


Figure 4-3: Control Unit Major Internal Components

**WARNING:** HAZARDOUS VOLTAGES EXIST ON CERTAIN COMPONENTS INTERNALLY WHICH MAY PERSIST FOR A TIME EVEN AFTER THE POWER IS TURNED OFF AND DISCONNECTED.



The 5000BF Control Units contain the following major components:

- Power Supply
- Motherboard (with Microprocessor, RS-232 chip, and Preamplifier PCB)
- Front Panel Display Board and Displays—
  - 5 digit LED meter
  - 2 line, 20 character, alphanumeric, VFD display

See the drawings in the Drawings section or addendum in back of this manual for details.

### 3.0 Routine Maintenance

#### 3.1 Automatic operation and routine operational duties

The system operates continuously without adjustment. Under normal conditions, after you program the system for automatic operation, only routine maintenance procedures are necessary. The most common failure condition is a temporary interruption of the power serving the instrument. If the power service is interrupted, the source lamp in the analyzer will restart automatically as long as there is no defect in the lamp circuit or its starter.

You can detect a lamp off condition with the signal failure alarm circuit, but you must connect the relay contacts from the alarm to your indicating device. In addition, you will experience an alarm condition when the cell windows are extremely dirty or the electronics fail in the detector-converter, log amplifier, or inverter circuits. When the alarm circuit is powered independently from the analyzer power source, the alarm circuit is fail-safe and will detect power failure.

A message such as "Cell Fail check the detector signal" might be displayed if a lamp off condition occurs.



---

### 3.2 System Visual Check and Response Procedure

1. Verify that the signal failure alarm is not in failure condition.
2. Verify that the zero and span control setting have not been disturbed.
3. Verify that the chart recorder contains a normal display.
4. Verify that the recorder has a sufficient supply of chart paper and ink.

### 3.3 Routine Maintenance

Keep the sample lines and components, including the measuring cell within the analyzer sample module, free of deposits and leaks. You must determine the interval between cleaning procedures empirically, because the duration of time that the system runs without attention is related directly to the sample's condition.

### 3.4 Suggested Preventive Maintenance Schedule

#### DAILY

1. Visually inspect the complete system for obvious defects, such as leaking tubes or connectors.
2. Verify that the sample pump (if applicable) is running.
3. Verify that the signal failure alarm is not in failure condition.
4. Verify that zero and span settings are correct.

#### WEEKLY

1. Examine sample cell windows for accumulation of solids. Remove and clean as necessary.

2. Calibrate the system.

#### ANNUALLY

1. Check the electronics calibration.

2. Check the UV source.

**NOTE:** *Be sure to wear UV filtering eye goggles.*

3. Check the solenoid valves.

### 3.5 Service Procedures and Adjustments

#### 3.5.1 Electronics

TAI aligns the system's electronics. However, you may need to touch up the circuitry, using the following procedure.

##### *Equipment Required:*

Oscilloscope (dual trace is preferred, but not required) To observe oscilloscope test points switch the vertical input selector of the scope to DC.

Switch to AC to observe the demodulator switch signals.

DVM (Digital Voltmeter)

PC Board Extender

Use the PC board extender whenever you need to adjust trimpot. Because all PC board connectors are keyed to avoid wrong positioning in the connectors, you must remove the key and after testing you need to replace the key with long-nosed pliers. Turn off the power during this operation. Never disconnect or connect the PC boards with the power on, because you may damage the PC board C-MOS devices.

### 3.5.2 Power Supply Test Points

Measure +15 volt  $\pm 1$  volt DC and -15 volt  $\pm 1$  volt DC on the differential power supply PC board in the control unit. Refer to the power supply schematic in the back of the manual to identify the power supply test points.

### 3.5.3 Setup of the Signal Processing Front-End Amplifiers

Fill the sample cell with air or a stable fluid, such that the photo energy that strikes the detector is constant. A stable fluid is distilled or tap water. This step may be omitted when the system is stable in its present state.

If you open the detector module, keep stray light out by covering the opening with a dense black cloth. If you do not take this precaution, the result is a misinterpretation of the scope patterns. On general-purpose systems, the scope test points are in the bottom of the detector module and are accessible without opening the module.

### 3.5.4 Oscilloscope Display of the I to E Converter Output

The output of the I to E Converter is observed at the output of the second amplifier. The objective of this operation is to set up the optical system and the gain of the second amplifier in such a way that the analyzer keeps operating within its dynamic range.

Connect the oscilloscope to TP3. The oscilloscope displays the measuring and reference pulses in an alternating pattern. The display is created by the light passing through the reference and measuring filters as they are brought in and out of the light beam by the rotating filter wheel. These light pulses are converted to electronic energy which is amplified and brought to TP2. The base line represents the blocking of the light beam by the opaque part of the filter wheel.

To identify which of the pulses is the measuring peak, insert the span filter (when present) or a piece of flat glass or clear plastic in the light beam. The peak that becomes the shortest (retracts excessively) is the measuring filter pulse.

---

In case you cannot set the gain properly, because the peaks are too short, too tall, or too much out of balance, adjust R2 trimpot on the converter PC board until you obtain the desired peak height as observed on the scope (usually 8 to 9 volt) for the tallest of the two peaks. Never leave the system operating with peaks exceeding 10 volts or you may saturate the logarithmic amplifier. You should not permit oscillations or distortions in the peaks.

### 3.5.5 Balancing the Optics for Equal Light Transmission with Zero Fluid in the SAMPLE CELL

The objective of this procedure is to obtain measuring and reference peak heights as displayed on the oscilloscope that are approximately equal, with the tallest peaks set at 8 to 9 volts. This must be done with air or zero fluid in the cell.

The procedure is purely mechanical and consists of adjusting the amount of light passing through either the measuring or reference filter, never both. Screens (wire mesh) of varying density are used for this operation and are part of the small tool kit accompanying the instrument.

1. Observe the oscilloscope and judge if optical balancing is needed. When the difference is less than 1 volt, balancing is not required. The tallest of the two peaks should be adjusted to 8 or 9 volts with the gain control R2 on the detector PC board. When this cannot be done because both peaks are too short or too long, search for screens mounted in the light path, usually located in a holder on the light pipe which interconnects the detector and sample module, and remove or add screens, as necessary.
2. When balancing is needed, identify the peaks as outlined under Section
3. For example, if the reference peak is the shorter one, stop the filter wheel with your hand and see if screens are located behind the reference filter. The reference filter is identified by the letter "R" engraved on the filter wheel.
4. If screens are found, remove them after taking the filter wheel off the shaft with the special Allen wrench supplied in the tool kit.

5. After removal of the screens and remounting the filter, mount the filter wheel back on the shaft. Position it correctly on the shaft by lining up the two paint marks on shaft and wheel.

6. Turn on the instrument and observe the balance on the oscilloscope.

a. If the reference peak is now too tall, remove the filter wheel and add a screen of lesser density behind the reference filter. Repeat this procedure until the peaks are within 1 volt of each other.

b. If the measuring peak is equal to or within 1 volt of the reference peak, the system is optically balanced and ready for calibration.

c. If the peak is still too short, repeat the procedure, but this time put a screen behind the measuring filter to shorten its peak.

7. After the peaks are balanced, adjust the gain control until the tallest of the two peaks is 8 to 9 volts. The peaks should still be within 1 volt of each other.

8. It is always good practice to operate the analyzer with as low a gain as possible. Therefore, with the gain control just barely off its stop, once again remove or add screens in the light path to obtain as high a voltage as possible without exceeding 9 volts for the highest peak. Read just gain for 8 to 9 volts.

This concludes the balancing procedure and the instrument is ready for calibration.

### 3.5.6 Setup of the Logarithmic Amplifier

The amplifier is inverting and continuously taking the logarithm of the output signal of the second amplifier. You can observe the output by connecting the scope probe to TP4.

The correct wave shape has a rounded negative going pulse that is the signal and a flat-topped positive pulse that depicts saturation of the log amplifier.

*You should not permit distortions or oscillations in the rounded peaks.*

---

When the positive going pulse is not flat or is distorted, adjust trimpot R3 only enough to obtain a flat positive pulse. If you over adjust, you may lose part of the second decade of absorption and affect the accuracy of analysis for high concentrations of the component of interest where the measuring pulse can become very short. The log amplifier saturates because the amplifier is incapable of taking the logarithm of the slightly negative baseline.

### 3.5.7 Inverting Amplifier

The amplifier is inverting and has a gain of 1. It inverts the output signal of the logarithmic amplifier and acts as a buffer between the logarithmic amplifier and the reed switch and integrators. To observe the output of the inverter, connect the scope probe to TP5. The wave must be a duplicate of that observed on TP4, except that it is inverted.

### 3.5.8 Integrated Reference and Measuring Signals

You can observe the reference and measuring signal at the first stage of integration by connecting the scope probe to TP6 (reference signal) and TP7 (measuring signal) at the detector unit. A dual trace scope is advantageous but not required for this observation.

The test points' significance is that they reveal proper switch action. The display shows a sawtooth pattern that is a charge-discharge of the first capacitor in the integrating network. This ripple is the AC component of the reference and measuring signal after the pulses are converted to DC. The sawtooth patterns must be displayed 180° with respect to each other as viewed with a dual trace scope. They must both be present.

If one is missing, the switch is not switching. If the sawtooth shows a broken pattern, the switching action is feeble or irregular. Usually, you can fix the faulty condition of the switch by slightly changing the switch position.

The action of a bar magnet and a rotating chopper disc activate the magnetic mercury reed switch. An aluminum motor mounting block houses a bar magnet. This bar magnet is parallel with the mercury chopper switch.

The chopper disc is a green and black disc mounted on the filter wheel shaft next to the motor. The disc is composed of both magnetic and non-magnetic materials. As the shaft rotates, the magnetic portion of the disc shorts

the magnetic flux as it passes between the magnet and the switch. The non-magnetic portion of the disc enables flux lines from the bar magnet to activate the mercury switch.

### 3.5.9 Battery-Powered Oscilloscope Synchronization Point

Because the line frequency cannot synchronize battery-powered oscilloscopes, use TP8 at the detector module to provide external synchronization.

## 3.6 Interface Board Terminals Strip

At the bottom of the interface PCB on the Control Unit, are three terminal strip where wiring is distributed to other sections of the Model 6000B System. Such as AC power for the D2 lamp power supply, DC Power to the preamplifier, High DC voltage for the photodetector, and signals to control calibration solenoids and filters. To gain access to this terminals, the silkscreen cover must be removed. These terminals are wired in the factory.

**WARNING: DANGEROUS HIGH VOLTAGES ARE PRESENT AT THESE TERMINALS. TRAINED PERSONNEL MUST REMOVE THE SILKSCREEN COVER ONLY. EXERCISE EXTREME CAUTION.**



The first strip terminal has three contacts labeled N, G and H. The labels stand for Neutral, Ground, and Hot. This is the AC power strip terminal. It feeds AC power to other components of the Model 6000B System, such as the D2 lamp power supply, heater, and temperature controller PCB.

The second strip terminal has four contacts labeled SHLD, SIG, GND, MEAS and REF. This strip terminals are dedicated to the signals coming from the photodetector amplifier. The labels stand for:

**SHLD:** Shield. Shield from the preamplifier cable connects to this contact.

**SIG GND:** Signal Ground. Ground reference for both the measure and the reference signal.

**MEAS:** Measure Signal voltage.

**REF:** Reference Signal voltage.

The third terminal strip has eight contacts labeled -230 VDC, +15 VDC, -15 VDC, COM, SPAN FLTR, SPAN SOL, ZERO FLTR, ZERO SOL. This strip feeds the high voltage needed on the cathode of the photodetector, DC power for the photodetector preamplifier, and control signals for the solenoids and filters. The labels stand for:

**-230 VDC:** This is the negative high voltage fed to the photodetector cathode, about -230 VDC.

**+15 VDC:** Power Supply voltage fed to the photodetector preamplifier, +15 VDC.

**-15 VDC:** Power Supply voltage fed to the photodetector preamplifier, -15 VDC.

**COM:** Common reference to the +/- 15 VDC and the -230 VDC power supplies.

**SPAN FLTR:** Span filter signal, AC voltage.

**SPAN SOL:** Span solenoid signal, AC voltage.

**ZERO FLTR:** Zero filter signal, AC voltage.

**ZERO SOL:** Zero solenoid signal, AC voltage.







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OPERATING INSTRUCTIONS

# Model 5000BF

## *Photometric Analyzer*

### Part II: Analysis Unit

NEC Type

**5000BF - GP, Rack, Panel (Integral or Remote)**

**5000 - GP, Bulkhead (Z-Purged in Div II areas)  
I, II, B, C, D (Integral)**

**5000BF-(X-Purged, 1,1, B, C, D) (Integral)**

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## Model 5000BF Photometric Analyzer



### 4.0 Operations

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Before shipment, TAI calibrates the analyzer for your application when feasible. Calibration data is listed in the Appendix. Prior to calibration, TAI checks the electronics of the analyzer and makes all of the necessary internal printed circuit board adjustments. Calibration is performed to determine the proper or close proximity zero and span settings, and also to verify that the analyzer response is linear.

After calibration, TAI makes a lengthy stability check to insure that the analyzer performs within all specifications. We advise that you recalibrate your equipment as part of start-up for the following reasons:

1. During shipment, it is possible that components have been jarred out of position or damaged.
2. Your process may be of a proprietary nature. Beyond checking electrical stability, TAI is unable to make a meaningful calibration of the system, requiring these adjustments to be made by you.
3. In other cases precise calibration from the original feasibility/proposal may have determined field calibration of the analyzer connected to your process stream is required and accuracy will only be obtainable upon representative matching and use of the actual process fluid background components at the operating physical conditions of flow, pressure and temperature of the sample.

In any case, it is important that you calibrate the analyzer when it is first installed. Zero checks should be made routinely once or twice a week and span calibration should be performed weekly, at first, and monthly after reproducibility is assured.



## 4.0 Operations/Analysis Unit

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### 4.1 Control Functions

#### 4.1.1 Analysis Section, fully explosion proof, Z or X purged Nema enclosure or Cenelec Purged (pending).

The control functions for the analysis section are located on the Front of the Enclosure module:

1. **POWER ON/OFF:** This function is hard wired into the enclosure for power to the control/analysis section.

2.a

$$X = \frac{(C-A)(1000)}{(B-A)}$$

For example, if the range of analysis is 20-80%, and a desirable alarm setpoint is 30%, then A = 20, B = 80, and C = 30

$$X = \frac{(30-20)(1000)}{(80-20)} = 167$$

- 2.b **RANGE:** Control unit allows changing the range by some predetermined amount, such as 4X or 5X; i.e., triple range: low range of 0-100 ppm, mid of 250ppm and a high range of 0-500 ppm.

3. **Mode:** Programmable functions for incorporating an automatic zero, span or autoranging. Autocal also possible with fluids by valving or by filter solenoid.. Consult control unit sections of the manual.

4. **Digital display:** indicates the concentration of the component of interest. Consult control unit section for setting up units as ppm, mg/l, %, etc.

#### 4.1.3 Explosion-Proof Version: Control Module

When the control module is integral with the analysis section (single explosion-proof enclosure), it has all of the same control functions as the General Purpose control module, however, the buttons are replaced by two switches. These switches have different movements to achieve the same functionality as the 4 button model. (Consult factory or assure the manual has the correct version of the front panel control switches and functions.





The control unit digital display must handle functions for both the analysis section and the control module.

### 4.2 Start-p

Information contained in this paragraph is based on the premise that the analyzer has been properly installed as outlined in Chapter 3.0, and that it is in operable condition. If difficulties arise during start-up, it is probable that some form of damage has incurred during shipment or some installation error has inadvertently been made.

Accessory test equipment is not necessary for start-up of the 5000BF.. However, if the analyzer malfunctions at start-up, an oscilloscope and a multimeter will be required for troubleshooting (see Chapter 5.0). TAI recommends that a dual trace oscilloscope be used. A dual trace oscilloscope will permit the operator to see two different waveforms simultaneously.

#### 4.2.1 Preliminary Inspection

Before power is supplied to the analyzer, all modules should be opened and inspected for damage or loose components. Plug-in circuit cards should be firmly seated in their sockets. All barrier strip wiring connections must be inspected, and user-installed wiring between units verified as being in agreement with the system interconnection diagram.

#### Control Settings

Prior to turning on the power, the controls on and within the control module should be positioned as follows:

##### Analyzers not equipped with Auto Zero

1. ON/OFF functionality hardwired at customers remote terminal block or power switch.
2. SPAN control preset to the setting noted in Specific Application Data in the Appendix.

##### Analyzers equipped with Auto Zero

1. ON/OFF functionality hardwired at customers remote terminal block or power switch.
2. SAMPLE/ZERO switch on ZERO.
3. SPAN control preset to the setting noted in Specific Application Data in the Appendix.



## 4.0 Operations/Analysis Unit

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### 4.2.2 Pre-Start-up Electrical Checkout

After the preliminary procedures have been accomplished (refer to Preliminary Inspection and Control Settings, above), the integrity of the system interconnection and the power sources must be verified before attempting the analytical start-up procedures.

The observations and measurements described in the following paragraphs are vital to the operation of the analyzer. If the analyzer does not respond as described, the equipment has been damaged in shipment or installation, or the user-installed wiring is in error. If a problem arises, correct it before proceeding further.

The following procedures should be employed in the same sequence in which they appear.

### 4.2.3 Power On Observations

Turn both the analysis/control module at the remote wiring panel of customer to ON and make the following observations:

1. Open the control/analysis section detector module and verify that the chopper motor is operating. Open the cover of the compartment and verify motion. The motor should start turning the instant power is established. If it does not, check the integrity of the main fuse on the control module door. If the fuse is blown, re-check the power service connections on TS2 in the control module, and the control module to analysis section interconnection wiring (refer to Electrical Installation in Chapter 3.0: Installation, and dwg. \_\_\_\_\_).
2. The lamp source should light the instant power is established. Open the enclosure door and view the source module to verify illumination.

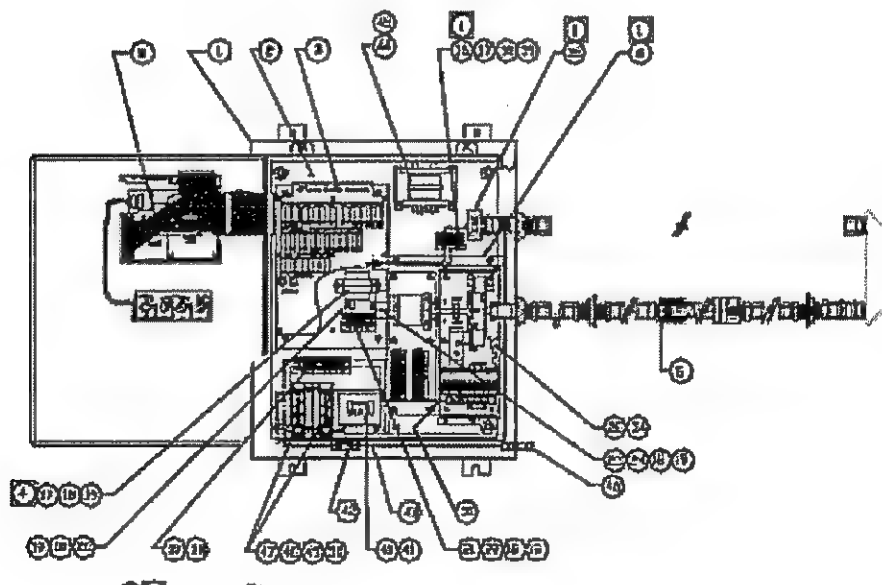
**WARNING:**

1. The light intensity from the Mini IR lamp or quartz iodine lamp If used is intense and should not be looked at directly without special protective eyewear. Protective goggles with shaded lenses (Fed. Spec. #5) should be worn if it is necessary to look directly at the source.
2. Before opening any of the enclosure covers with the power on, make certain that the area has been classified as safe to do so.



3. If the analyzer section has been equipped with the automatic zero SOL option, the zero solenoid device in the accessory sampling system should have energized the instant power was established. The device (or devices) should be energized because the mode switch has been preset to the ZERO position.
4. If the test procedure was normal, the devices should have been seen or heard to operate as described by personnel located at the analysis section installation site, and no further check need be made at this time. If operation is not as described, refer to Troubleshooting in Chapter 5.0.
5. Check analyzer operation by completing the calibration procedure described below in Calibration after allowing the instrument to warm up. The electrical circuits take from 30 to 40 minutes to stabilize.

**NOTE:** It will take at least four hours for the analyzer to completely stabilize with respect to temperature.



## 4.0 Operations/Analysis Unit

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### 4.3 Calibration

#### Standardization Fluids

Two standardization fluids are necessary to calibrate the analyzer:

1. **Zero Fluid:** The zero standard fluid must have a composition similar to the sample, and ideally, contains none of the components of interest. The zero fluid should be laboratory analyzed to determine its composition. The exact composition must be known, as the accuracy of the analysis can be no better than the knowledge of the standardization fluid.
2. **Span Fluid:** The span fluid must be representative of the sample fluid in composition (like the zero fluid), and contain a measured quantity of the component of interest. The component of interest content of the fluid should be in the region of 75% to 100% of the range of measurement. As with the zero fluid, the accuracy of the system is dependent upon the your knowledge of the span fluid composition. Ideally, the span sample should contain at least 75% of whatever the instrument is set up to analyze.

#### Procedure

1. Introduce zero fluid (see above) into the sample cell. Flow liquid samples into the cell at a flow rate of about 50 cc/minute to allow the sample to completely flush to a steady state concentration. Make certain that bubbles are not introduced or formed in the cell. (Some back-pressure may help avoid this.) Gas samples can be introduced at about 200-500 cc/minute.
2. The digital meter should be capable of adjusting the zero level to an on scale reading. Consult section for zero functioning. If the reading cannot be adjusted then the signals will require rebalancing for your particular process fluid. The filter wheel located inside the detector module must be removed and balanced optically with screens. See section: \_\_\_\_\_
  - b. If the measuring peak is so far out of balance with the reference peak that it can no longer be adjusted with potentiometer R3, the optical filters require re-screening. If the analyzer has been in use for some time, it is possible that the sample cell windows need cleaning or that a filter has deteriorated.



Another cause of peak imbalance might be that the sample chemical background has changed. In some cases, TAI is not able to duplicate the background your sample for purposes of optically balancing the analyzer before shipment. In these cases, it is necessary for you to screen for an approximate balance, and to then electronically adjust R3 for precise balance. To do so:

1. Reset R3 to its midpoint.
2. Re-screen the filter wheel, as necessary, to obtain a measuring voltage within 10% of the reference voltage. Every time a screen is added or removed from a filter, the analyzer must be turned off, and the filter wheel removed from the analyzer. When the filter wheel is replaced in the analyzer, its rotational position is not critical, but the white backing must face in the direction of the position sensor. The filter wheel must also be securely tightened, so that no slippage or vibration can occur. See Figure 5-1.

**NOTE:** Refer to Figure 5-1 when installing filter screens. Screens should be installed in the filter disk cup, under the filter holder. Also, if a balance ring is used, it should be placed over the screen.

- c. After screening to bring the measuring voltage to within 10% of the reference voltage, adjust R3 as in step a above to make the measuring peak voltage read the same as the reference peak voltage.
5. Turn the NORM/ZERO switch to ZERO. The analysis section meter should be made to read zero by adjusting the coarse ZERO control on the analysis section power module.
6. Check the control module SPAN setting to make sure it agrees with the calibration results obtained by TAI (see Specific Application Data in the Appendix).
7. Adjust the ZERO control on the control module to give a zero reading on the control module meter.
8. Add span fluid (see Span Fluid, above) to the sample cell. Make certain that all of the zero fluid is displaced.
9. Adjust the control module SPAN control to obtain the correct meter reading with reference to the concentration of span fluid. For example, if the sample contains 100% of whatever the



## 4.0 Operations/Analysis Unit

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instrument is set up to analyze, then the SPAN control must be adjusted for a full scale reading, i. e., 200 ppm water in EDC.

10. Re-check the ZERO setting with zero fluid.
11. If desired, the linearity of the analyzer can be checked with a fluid intermediate in concentration between the zero and the span fluid.
12. The analyzer is now calibrated. It is often desirable to check calibration (fine tune) on a dynamic sample from your process, double checking the 5020 analyzer response with laboratory analyzed grab samples. This is desirable where there is a possibility that your sample stream may have some background materials not in the makeup of the calibration fluid.
13. From time to time, re-check the zero setting. If it is found that there is no zero drift, re-checking the zero setting may become unnecessary or may be performed only on an occasional basis.
14. Some optical filters used in some applications will be so temperature sensitive that screening must be performed with the filters near the operating temperature.

### DIRECTIONS FOR USING TELEDYNE CALIBRATION OPTIONS FOR ON-LINE PROCESS PHOTOMETRIC ANALYZERS

#### I General

These calibration options consists of procedures for calibrating analyzers on-line. These techniques are offered when process conditions (high pressures, temperatures, sample phase changes) are extremely difficult to deal with and calibration standards are impossible, difficult to obtain, are too expensive to use due to volume consumption into the system, are unstable, or are difficult to introduce into the analyzer or sample system because of toxicity, pressure, etc. Also many times the sample stream composition is difficult to match with a calibration fluid.

In one case an optical absorbing filter(s) is inserted into the light path of the analyzer. The absorber is actuated by a switch(s) located on the readout panel of the control unit. The option functions by pre-



senting a calibrated and reproducible absorbance or fluid into the light path of the analyzer.

A zero may be established with a *reproducible* simulated (offset) zero absorbance fluid in the sample cell of the analyzer. When possible this fluid should be stable for H<sub>2</sub>O content and should approximate the process being measured to minimize the offset zeroing, otherwise, dry air or nitrogen can be used. The analyzer must first be calibrated for sensitivity full scale by using known certified/analyzed samples containing the component (analyte(s) to be measured.

### NOTES:

These samples (low/mid/high about 1 liter each) must be prepared and provided for introduction into the zero and/or span port of the sample system, with outlet collected from the cal return port of the sample system. A 500 to 1 liter glass syringe with Luor-loc to 1/4" tube connections should be used for introducing the samples into the analyzer sample cell for zero and span cal adjustments. These are introduced through the calibration ports usually labelled zero or span fluid inlets. The exiting samples when nontoxic are usually collected in waste containers from the cal-return port of the instrument cabinet. These cannot be used again as water vapor from containers and atmosphere will contaminate them. They would require analysis again before reintroducing for correlation purposes. Also, it is a good practice to flush copiously the sampling train with each calibration sample prior to accepting any read value. Each sample should be allowed to stabilize before reading. When a N<sub>2</sub> flush is used to dry the sampling train before each sample is read, the readings will come to equilibrium faster since no water cross-contamination should be evident or occur.

### 11 IF CALIBRATION PROCESS REPRESENTATIVE SAMPLES CANNOT BE OBTAINED, THEN A DIRECT ON-LINE TWO-POINT CALIBRATION APPROACH CAN BE USED AS FOLLOWS:

Assuming customer has designed in a sampling valve (this valve may contain a chromatographic septum port for a needle, i.e., for toxic or flammable samples at low pressure), hookup for a sampling bomb (high pressure), grab sample port, or sealed container to draw off representative process grab samples. Note: All samples are brought to the analytical lab for speedy analyses (preferably analyzed within 15 minutes) to correlate to process conditions. The sample analyzed should be by an analytical method with an acceptable precision and



## 4.0 Operations/Analysis Unit

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accuracy as used to normally monitor the process and confirm the on-line analysis. The on-line analyzer is only as accurate as the off-line method used to verify the process variables.

Below is an example of an on-line calibration when measuring 0-200ppm water in liquid TDI (assumes TDI is a toxic liquid at standard temperature and pressure conditions).

The first sample should be taken when the analyte (H<sub>2</sub>O) concentration is *known to be low* (approximately 0.002 % water). The sample is quickly withdrawn and analyzed in the lab to determine the water content via an acceptable lab method (This may be Karl Fischer titration, gas chromatography, IR spectroscopy or volume extraction/distillation, etc.). At this time, the instrument zero is made to read exactly zero on the output of the analyzer (i.e., on the % or PPM of the panel/digital meter, 4-20 ma current, or 0-1 VDC etc.) using the zero potentiometer of the analyzer or the digital or microprocessors zeroing calibration adjustment, **Record the lab value**, analyzed corresponding to the zero set-point adjustment.

A second sample from the process must be grabbed after a steady state upscale reading has been reached. Hopefully, at this time, the customer can make a minor changes in the process to cause a slight upscale reading (1 0-30% of the full scale or more if possible) in order to obtain a steady-state reading at another concentration level. If this is not possible, then an appropriate time interval must occur when the process naturally changes to an upscale steady-state level concentration. At this time the second calibration sample is grabbed and immediately analyzed. Record this value, This higher concentration value is subtracted from the first sample analyzed, **Its difference value<sup>1</sup> defines the slope of the calibration curve.**

**value<sup>1</sup>**- This value will be used to determine the calibration slope of the instrument range.

Using the span adjustment of the analyzer, set the output reading to agree with this difference in concentration. Once the slope is set, adjust the zero of the instrument to agree with the true concentration to that of the analyzed steady-state sample presently flowing through the instrument cell. Now the analyzer is calibrated to the process fluid.

**Zero calibration using secondary standard zero and span flag(s)**





AFTER the analyzer has been calibrated on the process fluid, a simulation of this process on-line calibration can be made using internal synthetic optical filters. These optical filters are stable and are chosen to indicate the measured component at the required instrument wavelengths. Therefore, future, faster, yet much simpler calibration zero and span checks can be made without the unnecessary tedious on-line calibration described above nor the consumption of expensive calibration fluids which may be difficult to handle or obtain, are unstable, or toxic in nature.

A Fitter(s) at the factory is chosen and installed in the instrument (approximating in absorbance value to the anticipated stream composition background) to give reproducible zero/ span value when nitrogen or air background is in the measuring cell. This capability is possible when the zero offset between the process fluid and dry air or nitrogen remains close to the zero point of the actual process fluid (i.e., after calibration, the zero offset can be adjusted over the entire range of the meter, plus or minus 100 % from zero). In the case of the calibration zero check value, the requirement for installing a zero optical flag with dry nitrogen as the background fluid depends upon how unbalanced the reference and measure channel peak heights are with respect to each other as measured using an oscilloscope at Test Point 1 (TP1 -Violet)) of the AGC- board designated B-1 4521-4. A good ratio (ref/meas.) estimate to keep within is (1 volt minimum: 2 volt maximum) to (2 volt maximum: 1 volt minimum) between the zero process fluid signal levels and the nitrogen calibration fluid background signal levels. With the process fluid in the cell at the zero point of the calibration range, the reference and measure pulses are optically balanced using density screens placed over the reference and/or measure filters. These signals are balanced to 9 volts each as measured at TP4 (ref-orange) and TP3 (meas-yellow) on the PEAK LEVEL DETECTOR BOARD designated B- 14074-A. The spectral background absorbance at the reference versus measure wavelengths of the process fluid determines the magnitude of the unbalanced ref/meas ratio. This ratio is kept within the 1:2 to 2:1 values for proper operation of the AGC circuitry and therefore proper stability and signal/noise levels of the instrument output. After balancing on a zero sample of the process fluid, if the ratio is not found to be within the 1:2 to 2:1 range, a zero flag is necessary and installed in the sample cell compartment along with a span flag if ordered. This zero flag when chosen is also solenoid actuated to bring the ratio within the 1:2 to 2:1 range between process zero fluid and zero nitrogen or dry air background. The span flag is actuated while the zero offset level (usually when nitrogen is used as a zero calibration fluid) is switched in.

### **Zero calibration check after process on-line calibration.**

To check zero on the analyzer, immediately back-flush out the process fluid and dry the cell out with a reproducible zero fluid that should never contain



## 4.0 Operations/Analysis Unit

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any of the analyte. (This is usually done with N<sub>2</sub> assuming the process fluid has low vapor pressure and can be purged dry in an acceptable short time period). In this case, nitrogen or dry air (typically -100°F dewpoint or 2ppm water) can be used. Manually switch in the *zero offset check* from the control unit to operate the zero solenoid flag (depending upon the application, this may or may not simultaneously insert a zero flag into the light path; indeed, 90% of the time it is not needed). The factory *zero offset value* was set from its best determined factory calibration and was approximately set between 10-20% of the full scale range for the zero. After the field on-line calibration, a zero offset value around a 10-20% meter range should be set, using the potentiometer adjustment located within the analyzer control unit to **bring it into the 10-20% range**. This may require a short term area declassification (on explosion proof units) in order to make this adjustment.

The zero offset adjustment potentiometer is panel-mount located within the control unit. The potentiometer identified (zero- offset) is adjusted while the reproducible zero fluid background is in the sample cell. (This zero check may be automatically or manually operated depending upon the sample system and electronic instrument design). RECORD the zero calibration reading for future reference and agreement checks of the zero stability.

Note the instrument zero reading should typically be between 10-20% of full scale calibrated range (chosen at the factory), *This reading should always repeat on nitrogen with the zero offset and/or flag introduced*. If not, readjust the instrument fine or coarse zero potentiometer (s) or microprocessor/computer etc., to read the correct concentration value known (determined after the original on-line process calibration).

Span calibration check after performing a process on-line calibration. After zero calibration above.

To check span on the analyzer, immediately back-flush out the process fluid and dry the cell with a reproducible zero fluid that does not contain any of the analyte. In this case, nitrogen or dry air (typically -75 °C dew point or less than 1 PPM water) should be used. Manually introduce the *span* flag from the readout control unit to operate the solenoid containing the appropriate *span* filter into the light path of the analyzer (this may be automatically or manually operated depending upon the sample system and electronic instrument design). RECORD the span calibration reading for future calibration reference of the span sensitivity agreement. The filter span flag is chosen at the factory to represent an upscale reading of typically between 60-90% of the full scale range.



**NOTE:** The zero or span flag readings should always repeat if the analyzer remains in calibration. Any drift in the zero or span can always be corrected using the calibration zero and/or span features.

## SUMMARY

The zero and/or span calibration of 5000 series photometric Teledyne analyzers can be quickly verified manually by using Zero and/or calibration zero offsets and/or span flags.

Refer to typical Teledyne Analytical 1475 sample system below, 3-way valves 1,2,+ 3 below are used to check internal calibration using zero and/or span filters with N2.

## CALIBRATION OF H2O IN SOLVENTS EXAMPLE

Based upon our experience when supplying photometric NIR analyzers for 0-100ppm water in solvents like EDC, TDI, benzene and the like, the following can be incorporated for the customers pertinent solvent.

- 1 Customer is responsible for introducing a reproducible dry zero fluid, typically (-75deg C) dewpoint Nitrogen or reproducible dry EDC or TDI etc., within +/- 1 ppm H2O (for accuracy of +/- 1 % full scale).
- 2 When customer supplies a reproducible dry TDI zero fluid: A span flag option is available to verify instrument full scale sensitivity. This optical flag may be (manually or automatically) introduced into the light path within the temperature controlled (within +/- 1 deg C) sample cell compartment. This optical span flag ( when in this temperature stable environment simulates a very stable upscale ppm H2O reading on top of the DRY reproducible TDI zero background.
- 3 Conversely, a zero flag and/or offset is (manually or automatically) switched into the light path of the analyzer after drying out the sample cell of process fluid. Consult your manual for the factor calibration values obtained.

### Actual concentration

### 5000/5020 series analyzer meter

#### Zero check

5 ppm water/TDI

5ppm water in the 5020 meter or output. Check.

or

0 ppm water in N2

5ppm water on the 5020 meter or output. with zero flag offset introduction.

delta 0ppm water or stability check on zero verified.

#### Span Check

mole-sieve or dried sample

(could be from process)

5ppm water in TDI

5ppm water on the 5020 meter or output. Zero verified.

85ppm water in TDI

85 ppm water as determined by Karl Fischer titration.

(grab sample from process)

(lab technique must be verified for precision)



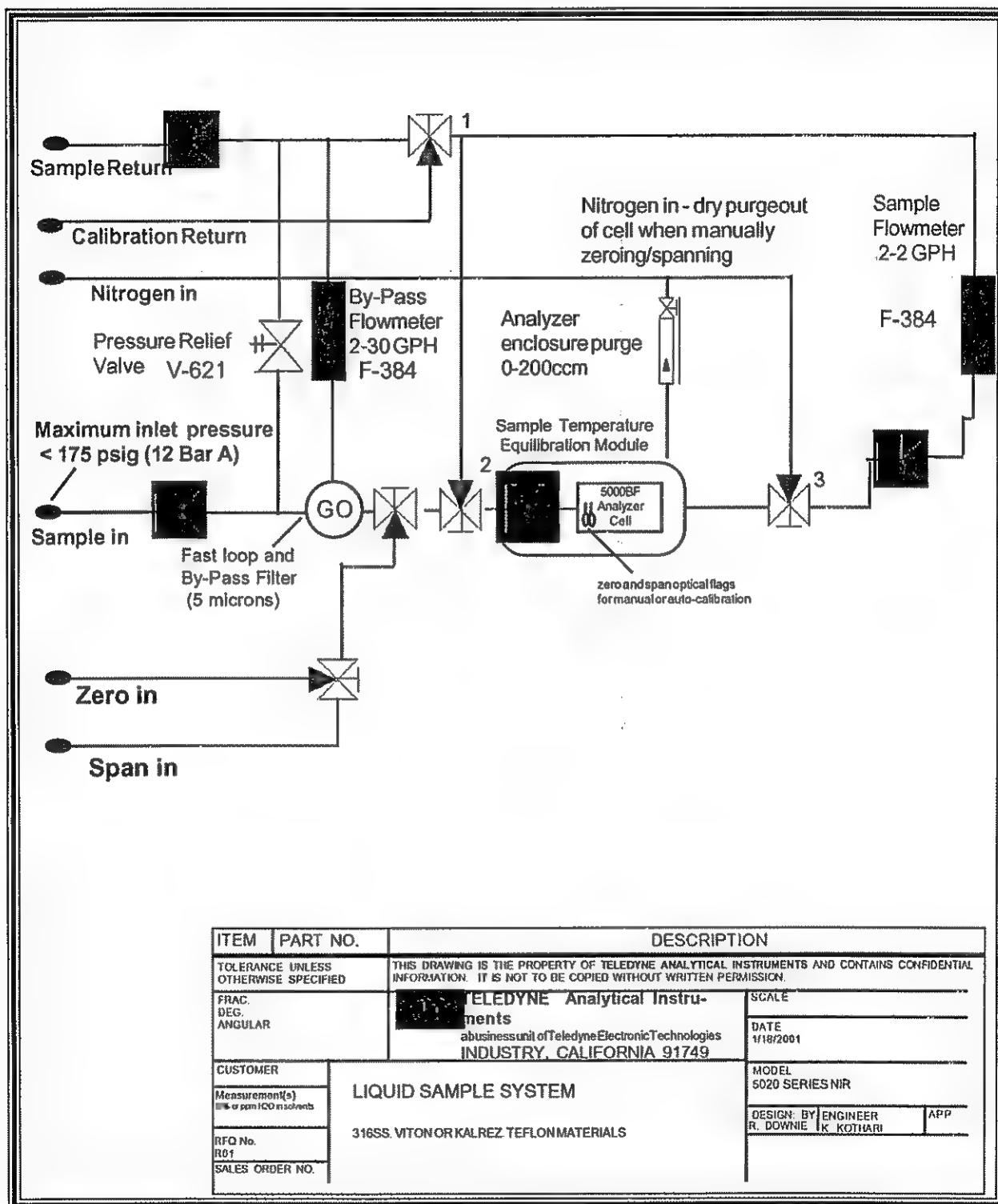
## 4.0 Operations/Analysis Unit

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titrator and operator nique)	(sampling device, Karl Fischer tech-
or	85 ppm simulated water using span flag on top of dry liquid TDI
	delta 80 ppm agreement on slope sensitivity.
or	
0 ppm water in N2	5 ppm water on the 5020 meter or output with zero-flag/offset intro.
0 ppm water in N2	delta 80 ppm simulated sensitivity change of water.

Note: the span flag checks the sensitivity change of the 5000BF and not the zero drift of the analyzer. The mole sieve dried TDI checks the zero of the instrument provided it can be reproduce the zero by consistently removing all the water to the same ppm level, (somewhere in the 2-10 ppm water range). The long term efficiency of removing the water by mole-sieve contact should be known for the customers process fluid, otherwise the customer should have an acceptable off line lab technique to analyze prepared samples before intro into the 5020 field analyzer. With Teledyne's approach, using N2 as the dry background for both zero and span checks, eliminates the concern of the mole-sieve being saturated with time. Indeed, the N2 Nitrogen background approach can be used to verify the inefficiency of the mole-sieve (saturation). Teledyne prefers this approach using easily reproducible N2 since it is much simpler to flush out the sample cell and check the instrument provided the original calibration on TDI is used to set up the zero and span instruments of the optical filters. See attached piping on how the appropriate valves are operated to switch in N2 in the reverse mode to provide a stable zero and or span check.





## 4.0 Operations/Analysis Unit

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### ATTACHMENT 5000BF/5020 NIR ANALYZER

Quote "Exceptions" and "LIQUID PHASE Conditions" for this application.

- 1 Response Time is proportional to sample system design for take-off distance, process pressure, line size, sequencing and bypass, by-pass analyzer flow design, dead-volumes/tee's, sample cell volume and instrument electronics.
- 2 Maximum cell operation pressure to be 175 psig, based upon standard Sapphire window cell design. Higher pressures available.
- 3 The sample flow through the analyzer should be regulated to within  $\pm 5\%$  of its recommended absolute nominal set point flow value (typically 20-60ccm). This will avoid any pressure drops across any orifices or poor temperature control of the sample.
- 4 The temperature of the sample from the take-off thorough the sample cell must be non-freezing, non-crystallizing, non-coating as provided by customer.
- 5 The sample temperature should not vary at the inlet more than  $\pm 15^\circ\text{C}$  of the calibration temperature, nor exceed the design operating specifications typically 5-45  $^\circ\text{C}$ . Assume sample below 45 C and requires no cooling.
- 6 Any background components later found to be present and not specified in the original application feasibility may void the instrument performance should they interfere. particulates assumed none.
- 7 If compounds are found present, such as moisture, acid gases or corrosive solvents, etc., the sample system materials may be compromised for corrosion resistance integrity. We assume that the sample will not polymerize, clog or react in any 1/4" sample line, filter or sample cell when transporting through the sample systems for all inlet ambient or sample pressures and temperatures from takeoff or derived from sample conditioning. Special materials may be required for stability, corrosion protection, coalescing, filtering, hazardous protection or due to heating or cooling.
- 8 We recommend when ambient temperatures exceed outside a 1-50  $^\circ\text{C}$  range that the instrument and sample system be conditioned appropriately for heating/ cooling without condensation, crystallizing, coating, polymerization, etc.
- 9 Should the general purpose or explosion proof instrument be supplied on a back-panel or as a bulk-mount housing, the customer must install to protect the instrument to meet harsh ambient conditions for dust, water, snow, wind, corrosion, etc.
- 10 Teledyne is not responsible for applying a general purpose instrument in a hazardous area or where a flammable or toxic gas or liquid is brought to an analyzer above its lower explosive limit and the area has been classified as general purpose and safe.
- 11 The internal calibration features using optical filters are optimized and used when the sample can be flushed (backflushed usually) out of the sample cell using dry nitrogen or air to a reproducible background zero. The zero offset and/or span flag is introduced and set-up to simulate the on-line calibration only after the customer has calibrated the analyzer on the representative process fluid. Thereafter, no calibration fluids are needed to check analyzer.



#### 4.4 Operational Theory Cont'd

The energy source for the analyzer is most commonly provided by a high intensity quartz iodine lamp located in the source module. Quartz iodine was chosen because it produces sufficient NIR to operate the system and maintains a nearly constant brightness over its lifetime. (See Figures 2-1 and 2.2).

This energy is then fed through the sample, which is temperature controlled, and into the detector module where it passes through a rotating filter wheel before reaching the lead sulfide (PbS) detector (PbSe also used for longer wavelengths (cooled and non-cooled)).

The filter wheel, driven at 30 RPS or 1800 RPM by a synchronous AC motor, contains two optical filters with bandpasses selected for each application, thus providing reference and measuring pulses from which the required information may be obtained.

The detector receives pulses at the rate of 60 PPS, or two pulses per revolution of the filter wheel. Every other pulse is from the measuring filter, while the alternate pulse is from the reference filter, so that pulses through the measuring filter alternate with pulses through the reference filter. A filter position sensor, which is an optical device having an integral light source and light detector, differentiates between the two.

The two entrained pulses received by the detector each revolution are amplified through a preamplifier which is physically located inside the sealed compartment with the filter wheel and detector. This signal is then sent to a clamping circuit where an exact zero reference is established.

This clamped video signal is then fed through a gain control network, which is controlled by the automatic gain control loop, through another amplifier, to the electronic switch. This switch is controlled by the switch driver network which derives its information from the filter position sensor in order to separate the entrained video signal into its component parts of a measuring peak and a reference peak. These peaks are then fed through a balancing network and channeled into separate peak height detectors which produce DC voltage levels which are exactly equal to the peak height or absolute magnitude of the voltage from the base to the peak of each of the pulses.

At this point the reference signal is fed back to the automatic gain control loop to maintain the desired system gain. In addition, both the measuring and reference levels are fed to selector switches in order to enable direct meter indication, which greatly eases the task of balancing the system during initial system installation and periods of calibration.



## 4.0 Operations/Analysis Unit

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The DC voltage levels are fed to a logarithmic ratio amplifier which produces a voltage output that is proportional to the logarithm of the ratio of the two DC input voltages. This output voltage, directly proportional to the concentration of sample, is, within certain limits, a linear function of the concentration. For purposes of transmission, the voltage signal is converted by an E-to-I converter; thus, the output signal from the analysis unit is a current signal that is proportional to the concentration of sample in the sample module.

There is also an option of providing an automatic zero function (see drawing B-14729) in the control unit. This circuit provides electrical signals for switching a fluid which contains none of the material to be measured into the sample module, electrically adjusting the zeros and switching back to sample.

### 4.1 Circuit Descriptions

#### 4.1.1 Source Module

The source module is the source of infrared energy. This is provided through the use of a high-intensity mini IR lamp or a quartz iodine lamp operating directly from a 5.0 volt stable supply or a 6.3 V transformer. To ensure a stable source of radiation in the face of line-voltage variations, the lamp transformer derives its input directly from a line voltage-regulating transformer, selected for its ability to maintain a constant output voltage level regardless of fluctuations in the input line voltage within the control range of 105 to 130 VAC.

In some applications where we have an abundance of energy due to low sample absorption, the focusing lens is removed to avoid excess energy reaching the detector. However, other systems have high energy losses in the sample module due to strong sample absorbance or exceptionally long sample path-lengths. These systems require a focusing lens to gather and collimate the radiation for maximum utilization of source energy. The collimating lens is usually quartz, but may be CaF<sub>2</sub> for longer wavelengths. Also the source lamp may be a different type, to emit more radiation at the longer measuring wavelengths. (Consult manual addendum descriptions).





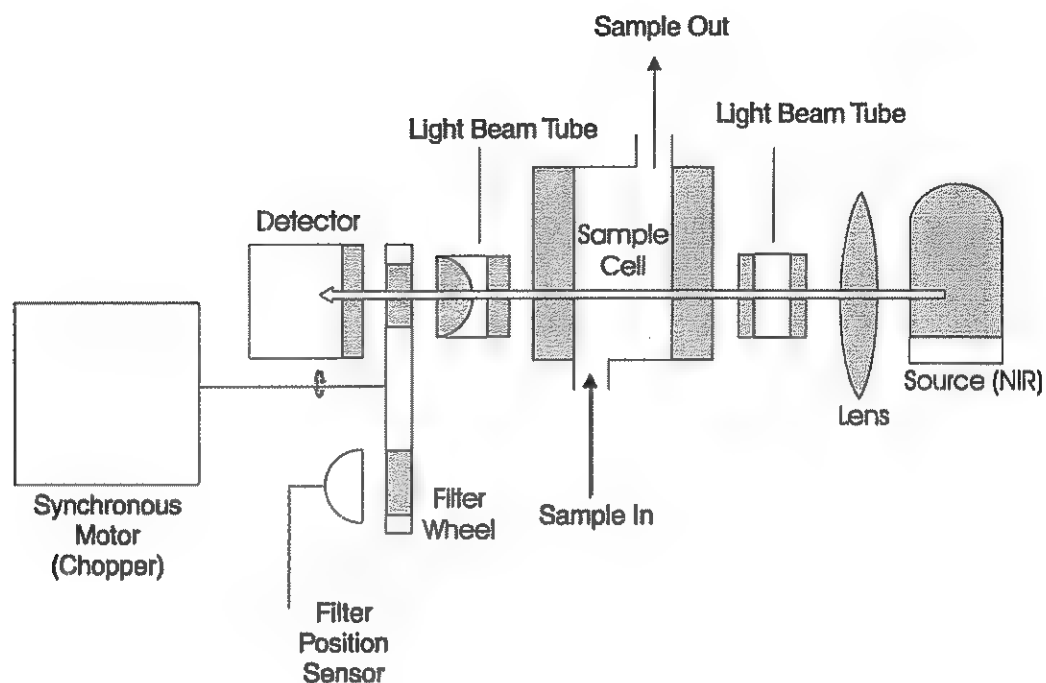


Figure 2-1. Optical System

#### 4.1.2 Sample cell

The sample cell, generally constructed of 316SS, is located in the path of the NIR radiation, between the source and the detector modules. Each compound in the sample path exhibits its own characteristic absorption spectrum. Cell spacer thicknesses will vary depending upon the absorbance of the component of interest at the measuring wavelength. Due to the possible variation of absorption with temperature, it is either necessary to maintain the sample at a constant temperature during analysis or to compensate for the minor frequency shifts of the water bonding which can change due to sample temperature variations. To achieve this, two separate methods of temperature control are employed for constant temperature control.

1. A preheater (heat exchanger coil) is used on the incoming sample stream to raise or lower it to the desired temperature controlled level.
2. The entire sample module is separately controlled to maintain the sample temperature during analysis.



## 4.0 Operations/Analysis Unit

3. The sample is temperature compensated for by software while inputting the temperature value at the sample cell.

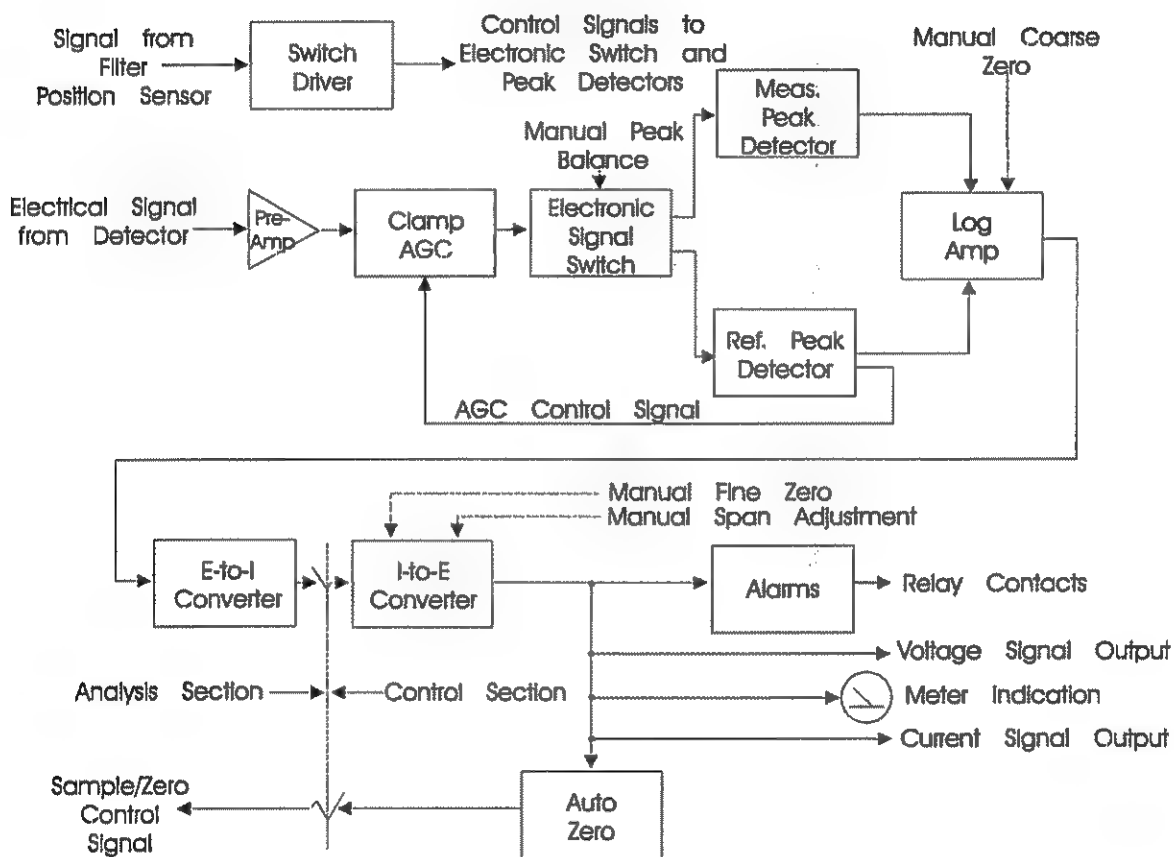


Figure 2-2 Analyzer System - Block Diagram

### 4.1.3 Power

See Figure 2-3. The power to the analyzer unit, enables the switching functions, and temperature control for the detector compartment.



With the microprocessor control unit, the following information is provided.

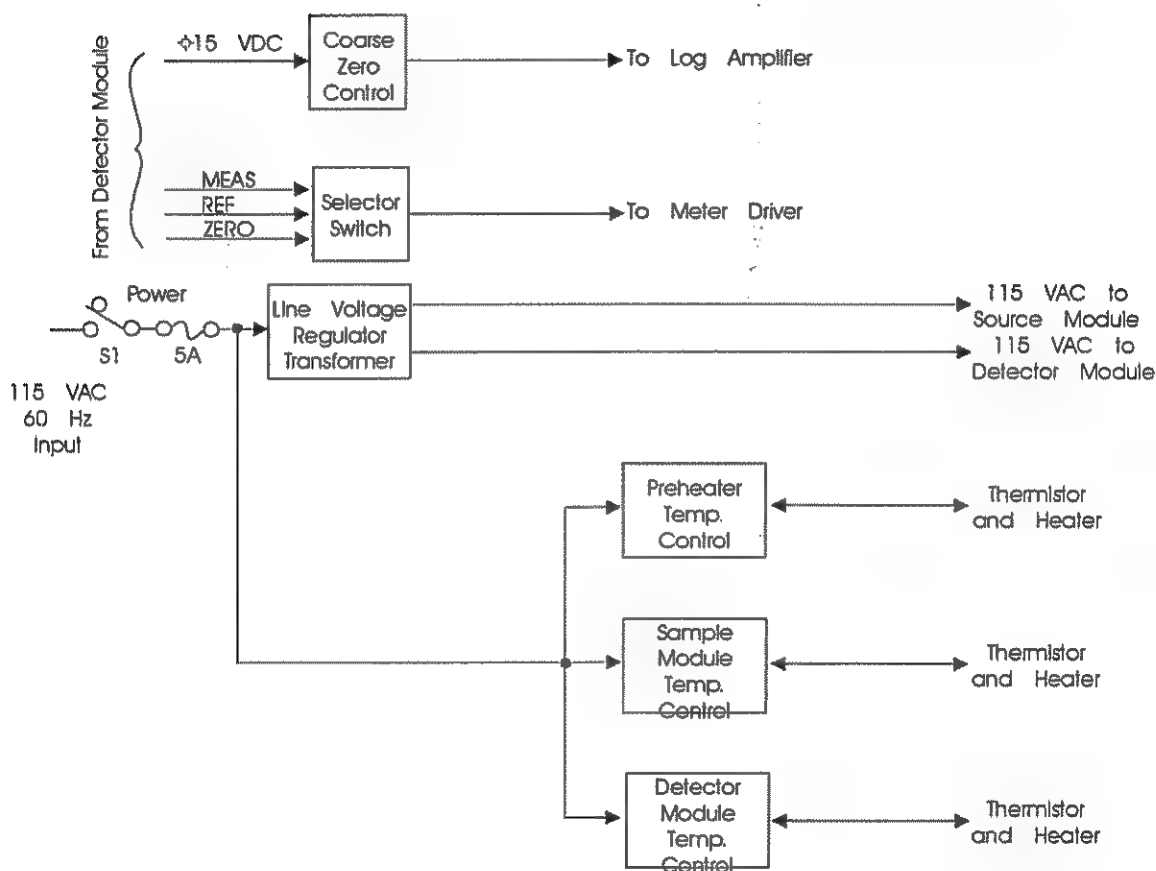


Figure 2-3. Power Module - Block Diagram

The temperature in the detector compartment is controlled by inputs from a RTD device which feeds to a PID controller capable of set points of temperature versus temperature readout.



## 4.0 Operations/Analysis Unit

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### 2.1.4 Detector compartment

After energy has passed through the sample, it arrives at the filter wheel where it is fed alternately through two filters (measuring and reference) before reaching the detector.

These filters are specially selected for each application according to the absorption characteristics of the compounds under analysis. The reference and measuring filter waveforms occur along a baseline at approximately 16 milliseconds intervals; each reference or measuring waveform reoccurs at a time interval of 33 mS, or one per revolution of the filter wheel.

At the detector, infrared energy is transformed into electrical pulses and fed through an impedance-matched preamplifier (see dwg. A-14619). Depending upon the application, length of the cell spacer, etc., the gain of the preamplifier may vary from 1 to 10, depending upon the energy intensity at the detector, to achieve an AC signal output of approximately 0.1 to 1.0 volt peak-to-peak.

Additionally, the detector, filters, and preamplifier are housed in an electrically and thermally isolated compartment to provide maximum stability and minimum noise. This box, or compartment, is normally temperature controlled at 46 °C.

As noted previously, the filter wheel is driven by a synchronous AC chopper motor which operates at 1800 RPM. The filter wheel performs two functions: (1) switching filters, and (2) chopping the optical signal to give pulses which can be amplified for high quality processing.





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## Appendix

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### A-1 Specifications

#### *5000BF Digital Control Module:*

**Ranges:** Four Programmable Ranges, field selectable within limits (application dependent) and Auto Ranging

**Display:** 2 line by 20 alphanumeric VFD accompanied by 5 digit LED display

**Signal Output:** Two 0-1V DC (concentration and range ID)  
Two 4-20mADC isolated (concentration and range ID)  
RS232

**Alarm:** Two fully programmable concentration alarm set points and corresponding Form C, 3 amp contacts. One system failure alarm contact to detect power, calibration, zero/span and sensor failure.

**Mounting:** Bulkhead Mount, NEMA-4 rated

**Operating Temperature:** 0-50°C

***Typical Analytical Performance Specifications:****(will vary per application)*

<b>Accuracy:</b>	$\pm 2\%$ of full scale or better, application dependent
<b>Noise:</b>	Less than $\pm 1\%$
<b>Diurnal:</b>	Less than 1% per 20°F (10°C (source/detector dependent)
<b>Sample Cell:</b>	Stainless steel with Sapphire window standard. Other materials available.
<b>Cell Length:</b>	.01 to 10 inches
<b>Flow Rate:</b>	50 to 1500 cc/min
<b>Light Source:</b>	Tungsten Mini-Lamp, optional Quartz Halogen
<b>Sensitivity:</b>	.015 to 3 absorbance units.
<b>Reproducibility:</b>	+/- 1% of scale or better
<b>Filter Wavelength:</b>	750nm to 5 microns, application dependant
<b>Sample Pressure:</b>	Sapphire window 250 psi
<b>Response time:</b>	Programmable

***Other Specifications:*****Ambient temp range:** 32-122 °F (0-50 °C)**Internal calibration:** Optical span flag/zero and span calibration

NOTE: 5000BF/5020BF (sample temperature sensing and output correction)

**Power Rating:** 115/230 VAC, 50/60 Hz, approx 200 watts**Readout Device:** Digital, 2 line alphanumeric vacuum fluorescent display, (VFD)**Analog Output Signal:** 0-1 V (standard), 4-20mA isolated**Area Classification**

Non-hazardous: Model 5000BF

Hazardous / Explosion-proof: Model 5020

5000BF, 5020BF Purge options: X, Y, Z purge, Cenelec IIB  
AND H2 (PENDING) FOR ZONE I OR CLASS I, DIV I, B, C,  
D AREAS

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**Enclosure Purging:**

Purge air startup\*: 40 – 80 PSI (3 – 6 BAR), 0.5 CFM (15 L / min)

Purge optical path\*: 15 – 30 PSI (1 – 2 BAR), 10 cc/min, purity of  
Nitrogen, - 110 °F (-80 °C) dewpoint

\* If ordered with purge option

**Other Features:**

- \* Three user selectable ranges
- \* Signal and Range ID output: 0-1 VDC and 4-20maDC (isolated)
- \* Programmable auto ranging
- \* Range ID contacts, 3A@250VAC resistive
- \* Two adjustable concentration alarm set points with programmable relay function Form C contacts, 3A@250VAC resistive
- \* Programmable auto calibration with mode ID Form A normally open contacts
- \* Remotely operated calibration (customer supplied valves) and 24 VDC signal), application dependent
- \* Self diagnostics with Form C failure contacts
- \* Full duplex RS232 communication link
- \* Alphanumeric VF display for set up and diagnostics

**General Installation Note:** Protect the instrument from direct sunlight and rain.



## A-2 Recommended 2-Year Spare Parts List

### QtyP/NDescription

	C-75825A	Motherboard, Control Unit
	C-67990	Amplifier, Control Unit
	D-67990	5000BF Interface PCB
1	A-9306	Differential Power Supply
1	C-40265A	Measuring PCB
1	B58206	IR source and parabola assy
1	C-54802	Controller, D2 Power Supply
1	C-14449	Temperature Controller, Sample Cell
1	L-179	Source Lamp
5	F-57	Fuse, 5A Slo-Blo
5	F-14	Fuse, 10A Slo-Blo
1	D3	PbS detector standard
2	C128	Sample Cell Window (sapphire)
6	O81	Viton O-Ring
1	A-16776	Accessory Kit
2	F1268	Fuse, 6.3 A Fast-blo

**Note:** Orders for replacement parts should include the part number (if available) and the model and serial number of the instrument for which the parts are intended.

Orders should be sent to:

### **TELEDYNE Analytical Instruments**

16830 Chestnut Street  
City of Industry, CA 91749-1580

Phone (626) 934-1500, Fax (626) 961-2538  
TWX (910) 584-1887 TDYANYL COID

Web: [www.teledyne-ai.com](http://www.teledyne-ai.com)

or your local representative.



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### A-3 Drawing List, 5000BF

**System Drawings:**

D75119	Final Assembly, Analyzer
D75061	Outline Diagram, Analyzer
Cxxxx	Interconnection input/output Diagram

**Schematics:**

A14619	Preamplifier
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**Wiring Diagrams:**

C-xxxx	Wiring Diagram, Control Unit
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**PC Board Assemblies:**

D69632	Main/Display/LCD/Pre Amp
C67435B	Main
C62371B	Display
C-72760	Amplifier PCB Schematic
D-67990	Interface PCB Schematic
A14505	Presamplifier

**Assembly Drawings:**

D75098	Control Unit Source and Detector
D69633	Customer Interface
C75099	Detector Module
D75101	Sample Cell Sensor Light Path
C75020F	Sample Cell 10" Monel w/Kalrez O-rings



